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The Communication Support System (CSS) and Its Planning and Management upon Implementation

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Submitted in partial fulfillment
of the requirements for the degree of

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ABSTRACT

COPERNICUS is the Navy's C^4I architecture envisioned to enhance command and control for the Composite Warfare Commander (CWC), Fleet Commanders-in-Chief (FLTCINCs) and, eventually, Unified CINCs. The Communication Support System (CSS) is both a system and architecture that will be instrumental in the realization of the Copernican TADIXS networks. The purpose of this thesis is to provide operations, communications and management personnel sufficient information regarding COPERNICUS and the CSS in order for them to have a basis for planning and managing CSS operations at its implementation.

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I. INTRODUCTION

COPERNICUS is the Navy C^4I architecture visualized as an interactive framework that will tie together the command and control process of the Navy tactical commander afloat, the Joint Task Force (JTF) commander, the numbered fleet commander and others with the CINCs ashore [Ref. 1:p. 3-1]. It will consist of four principal segments, or pillars: the Global Information Exchange Systems (GLOBIXS), CINC Command Complex (CCC), Tactical Data Information Exchange Systems (TADIXS), and Tactical Command Center (TCC). By making use of the newest communications and computer network technology, it is intended to see Command and Control (C^2) into and through the 21st century.

The Communications Support System (CSS) will allow the tactical commander, through the Space and Electronic Warfare Commander (SEWC), to control Copernican TADIXS in the same manner that other commanders control ASW, ASUW or AAW [Ref. 1:p. 8-11]. Thus, CSS is to become an integral part of the COPERNICUS architecture. With an Initial Operational Capability (IOC) of FY94, CSS is planned to route data between the TCC afloat and the CCC ashore. At its IOC, the Navy EHF Communications Controller (NECC) is a system that will operate under CSS with the new Navy EHF Satellite Program (NESP) terminals at a speed of 2.4 kbps. Thus, EHF satellite

communications (SATCOM) will become the first *bearer service*, or communications medium, to be provided as a Copernican TADIXS. Additional bearer services such as UHF, SHF, HF and commercial satellite communications (SATCOM) are also planned for incorporation into CSS.

Although COPERNICUS intends that the "command and control universe" revolve around the tactical commander, the Fleet Commander-in-Chief (FLTCINC) retains overall responsibility for operations within his Area of Responsibility (AOR), both as Naval FLTCINC and as component commander to his Unified CINC. This thesis is intended to provide an informational document for FLTCINC staff planners, operators, communicators and intelligence personnel alike so that they may gain a better understanding of the CSS and NECC, and of how these systems will work together toward fulfilling the plans conceived in the COPERNICUS architecture.

This thesis is also intended to provide the FLTCINC, numbered fleet commander and other cognizant organizations a basis for discussion in managing CSS and NECC at IOC for communications planning purposes. Ideas will be presented so that use and management of these systems within a FLTCINC's AOR may be determined and promulgated prior to the systems' IOC. Security issues will not be addressed in this thesis.

For the purpose of simplification, a top-down discussion of the Copernican structure and how each system fits into the

larger picture will be presented. The following paragraphs delineate subjects which will be discussed by chapter.

Chapter II will briefly describe the COPERNICUS architecture and its four pillars as currently envisioned. A short discussion of the SEW concept is included. TADIXS and its relationship to the CSS will be introduced to the reader.

Chapter III will discuss CSS. Discussion will include a more detailed description of its functions and segments, and the capabilities it is planned to provide. Its relationship to COPERNICUS and its benefits to C^2 will also be covered.

Chapter IV will describe the NECC. Included are discussions on EHF communications today, NECC's relationship to CSS, its functions, segments, and the capabilities it is planned to provide at IOC. NECC applications both in the near and far term will be presented. An appendix to the thesis provides a schedule of the capabilities planned to be provided by the NECC in the future.

Chapter V will bring together the previous discussions with a description of the NESP terminal in order to develop a CSS communications plan (COMMPLAN) and a CSS connection plan (CNCTNPLAN). A planning approach will be explained in order that planners may get an idea about CSS communications planning prior to IOC. Issues will be identified that may require discussion prior to CSS/NECC implementation. Recommendations will be made as to how those issues might be resolved.

Chapter VI concludes the thesis. A brief summary and recommendations will be presented.

II. THE COPERNICUS ARCHITECTURE

A. PURPOSE

The tremendous growth of Navy telecommunications, the increase in demand by its users and the acknowledgment of its critical role in supporting command and control (C^2) have resulted in the identification of three major problems with the current Navy telecommunications system [Ref. 2:p. 2]:

- Limited ability to separate critical sensor and operational traffic from mission support and/or administrative traffic. During conflict, decision makers must receive only the information they require in order to plan their actions. Administrative traffic competes with those messages whose timely delivery is crucial to successful operations.

- Overreliance on narrative message traffic and the lack of common information formats inundate the warfighting commander in data that cannot be readily assimilated and used. Precious time is often wasted in either interpreting or sorting through information from numerous sources in order to make a critical decision.

- Limited technical oversight of today's Command, Control, Communications, Computers and Intelligence (C^4I) architecture. Separation and lack of coordination among Naval C^4I components, as well as joint and allied components, often lead to duplication of effort, overtaxed communications resources, interoperability and security issues.

Additionally, with the massive amounts of information to be processed, reduced manning, and the complexity and sophistication of emerging systems, new computer architectures and applications will be required [Ref. 2:p. 14]. Only an

improved information management system that is state-of-the-art and can keep up with rapidly developing technological advances in telecommunications can remedy these problems.

In order to achieve a cohesive C^4I architecture that will fully support C^2, the COPERNICUS architecture has been defined. COPERNICUS will be constructed as an interactive framework that ties together the command and control process of the Navy tactical commander afloat, the Joint Task Force (JTF) commander, the numbered fleet commander, and others with the CINCs ashore [Ref. 1:p. 3-1]. It is also planned to support joint and Allied operations in the future.

B. THE SEW CONCEPT

The Warfare Mission Area (WMA) of Space and Electronic Warfare (SEW) was established in 1989 by the Chief of Naval Operations (CNO). The WMA is seen as the Navy's commitment to bring together elements of Electronic Warfare (EW), C^4I, surveillance and other tactical and strategic assets into a seamless SEW system. Together with other warfare commanders such as the Anti-Air Warfare Commander (AAWC), Anti-Submarine Warfare Commander (ASWC), and Anti-Surface Warfare Commander (ASUWC), the SEWC will provide support to the Composite Warfare Commander (CWC). [Ref. 1:p. 9-2]

The SEWC's role is anticipated to become fully developed within approximately ten years. In support of this development, SEW doctrine is currently being established. A

SEW Naval Warfare Publication (NWP) is being produced, and SEW subsystems are being identified. COPERNICUS, a SEW subsystem intended to support all commanders, will be delegated to the SEWC by the CWC [Ref. 1:pp. 9-2, 1-9].

C. THE FOUR PILLARS OF THE COPERNICUS ARCHITECTURE

The COPERNICUS architecture will consist of four pillars: the Global Information Exchange Systems (GLOBIXS), the CINC Command Complex (CCC), the Tactical Data Information Exchange Systems (TADIXS), and the Tactical Command Center (TCC).

1. GLOBIXS (Global Information Exchange Systems)

a. Discussion

The GLOBIXS are planned as worldwide or theaterwide limited access, high speed, highly concentrated virtual networks which will join shore-based commands or activities of like missions or interests [Ref. 1:p. 4-1]. (A virtual network is one which exists only for the time it takes to exchange information among users.) Besides allowing GLOBIXS members to send information to other shore-based members, GLOBIXS will transport, standardize, and concentrate shore-based sensor, analytic, command support, administrative, and other information for further passage to commanders afloat [Ref. 1:p. 4-1].

GLOBIXS terminal equipment are slated to consist of STU-IIIs and the Fleet All-Source Tactical Terminals (FASTTs), Copernican standardized computer hardware [Ref. 1:p. 4-15].

The FASTTs of members of a particular GLOBIXS network will share the same application software, and will be linked to the FASTT of their corresponding Operations Watch Center (OWC) operator at the CCC [Ref. 3]. These operators, acting in accordance with tailored doctrine established by each Officer in Tactical Command (OTC), will have the technological capability to determine whether and to what degree to filter shore-based information [Ref. 4:p. 90].

The tailored doctrine will be a CWC's C^2 plan, selected from matrices in a future COPERNICUS management NWP that will describe COPERNICUS GLOBIXS-TADIXS configurations [Ref. 3]. The CCC personnel will consolidate, size, and format the shore-based information from the GLOBIXS and send it over the appropriate TADIXS [Ref. 4 :p. 90]. The collection of GLOBIXS information the CWC selects may be independent from that of another CWC in a different communications area (COMMAREA).

Thus, it may be stated that CCC personnel will *anchor*--filter, sort, analyze, and move--GLOBIXS information for the tactical commander, and that GLOBIXS should afford the Composite Warfare Commander (CWC) the capability to receive information tailored to his needs in order to fulfill his specific mission [Ref. 1:p. 3-2]. If he so desires, the tactical commander may decide that some or all GLOBIXS information be anchored by afloat personnel, based on his personal preference [Ref. 1:p. 3-13]. Figure 1 [Ref. 1:p. 3-

4] illustrates how the CCC anchors will act as interfaces, or gateways, between the GLOBIXS and TADIXS virtual networks, taking information from their respective GLOBIXS networks to filter and consolidate it into a concise, uniform package that can be sent over the TADIXS to the TCCs. These personnel will similarly transmit "anchored" TADIXS information over their respective GLOBIXS networks [Ref. 1:p. 3-2].

Some programs related to GLOBIXS development are the Defense Data Network (DDN), a worldwide digital packet switched network; the Defense Message System (DMS), scheduled to replace AUTODIN; and the Defense Switched Network (DSN),

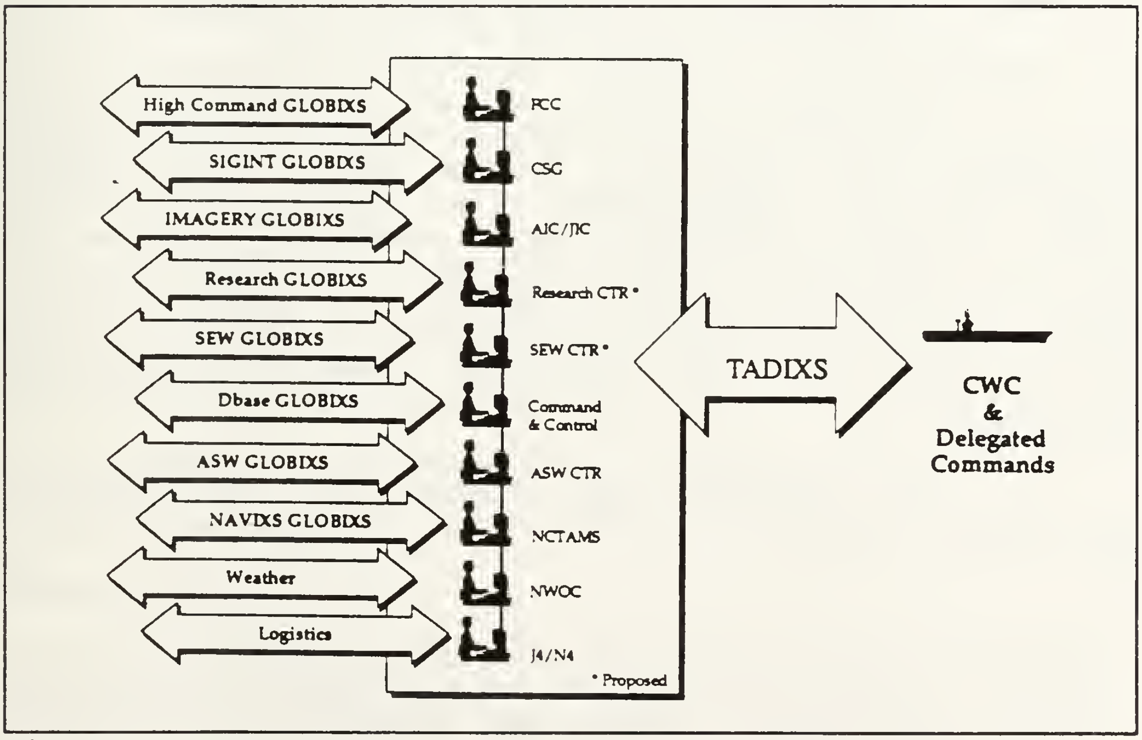

Figure 1. CCC Anchors

the primary DOD telecommunications network which has evolved from the AUTOVON network. [Ref. 1:p. 4-24]

b. GLOBIXS Networks

As stated previously, the GLOBIXS are intended to join shore-based commands of like missions or interests. Eight GLOBIXS networks are initially planned. Five GLOBIXS are operationally oriented and contain the major sensor and analytic nodes, both Navy and national:

- GLOBIXS A for Signals Intelligence (SIGINT);
- GLOBIXS B for Antisubmarine Warfare (ASW);
- GLOBIXS C for Space and Electronic Warfare (SEW);
- GLOBIXS E for Imagery; and
- GLOBIXS F for Data Base Management (where files may be moved to and from TCCs). [Ref. 1:pp. 4-2, 4-19]

GLOBIXS D will be a multimedia (video-teleconferencing, facsimile, secure voice) High Command (HICOM) network, connecting major commands such as the FLTCINC, Joint Task Force commander and numbered fleet commander [Ref. 3]. Its format will depend on the medium being used.

The remaining two GLOBIXS will be primarily supportive in nature:

- GLOBIXS G, the Research & Development Information Exchange System, which will provide for exchange of information among such organizations as Navy laboratories and weapons testing facilities

- GLOBIXS H, the Navy Information Exchange System (NAVIXS), the Navy's implementation of the Defense Message System (DMS), intended to support traditional narrative message traffic. [Ref. 1:p. 4-2]

The construction of a GLOBIXS is expected to be accomplished by little more than the connection of standard hardware onto a Defense Communications System (DCS) backbone at a proposed GLOBIXS node with tailored software applications [Ref. 3]. Therefore, a contingency GLOBIXS could be created to support no-notice operations if required. Similarly, additional GLOBIXS may be added to the architecture as the need arises.

The use of COPERNICUS Common (COPCOM), the Navy's planned binary digital format, and OPNOTE (a message format similar to that used by OTCIXS, the Officer in Tactical Command Information Exchange Subsystem) by net members of GLOBIXS A, B and C should provide true exchange of digital information [Ref. 1:p. 4-16], characterized by voice, imaging and digital data, not principally character-oriented textual information such as the AUTODIN message format being used today [Ref. 3]. The use of digital information will increase message traffic speed and volume over those *bearer services*, in this instance DCS and commercial circuits, capable of supporting them.

2. The CCC (CINC Command Complex)

a. Discussion

The CCC will include a number of existing organizations brought together technologically by common workstations (FASTTs) connected to a metropolitan area network (MAN) [Ref. 1:p. 5-2]. The CCC MAN, like GLOBIXS, is a virtual network, part of the Base Information Transfer System (BITS), a backbone scheme for basewide communications systems integration, which will interface to the DCS [Ref. 1:p. 5-15]. The wideband CCC MAN will connect to many, smaller, local area networks (LANs), also part of BITS, of those shore-based staff and command organizations whose information provides strategic and tactical mission support to the FLTCINC [Ref. 1:p. 8-2].

CCCs will be located at Oahu, Hawaii, Norfolk, Virginia, and Naples, Italy, and will be managed by CINCPACFLT, CINCLANTFLT and CINCUSNAVEUR, respectively. Each CCC may be constructed differently. A LAN within each CCC will provide gateways to the larger MAN, connecting the centers and providing gateways to TADIXS through the Communication Support System (CSS) and to shore GLOBIXS networks [Ref. 1:p. 5-6]. In other words, besides information generated by the CCC, both GLOBIXS and TADIXS information will travel over the CCC MAN.

Much like GLOBIXS, the CCC MAN is also planned to be flexible and dynamic by allowing the FLTCINC the capability

to add or delete members from its configuration according to operational scenario. Thus, the CCC MAN would also be capable of incorporating compatible LAN(s) of the Unified CINC, converting itself from a Navy network to a Unified network in order to support any joint or allied operations or the eventual joint architecture. [Ref. 1:p. 5-2]

The WWMCCS ADP Modernization (WAM), is a program under which current ADP systems are being redesigned and replaced. ASWOC Modernization is the installation of a LAN-based architecture at all ASW Operations Centers. Both programs are related to the development of the CCC, in addition to BITS. [Ref. 1:p. 5-15]

b. The Organizational Building Blocks of the CCC

As previously discussed, it is planned that the CCC will have the capability to manage the flow of information for the tactical commander. Six organizational building blocks are planned to constitute the CCC [Ref. 1:p. 5-4].

The *Fleet Command Center* (FCC) is the center of FLTCINC operations. In fulfillment of its duties to support the FLTCINC in the exercise of their responsibilities as naval component commanders, the FCC will manage theater resources, interface with designated net members for operational tasking and coordination and receive various informational reports as required [Ref. 1:pp. 5-7 - 5-8]. The FCC may also communicate via the CCC MAN with the numbered fleet commander, CWC,

operational units, other FCCs and supporting CINCs. The FCC will anchor GLOBIXS D, the Command GLOBIXS.

The *Operations Watch Center* (OWC), whose membership will be controlled by the CCC, is designated to be the heart of the COPERNICUS architecture ashore, serving as the gateway for the CWC into the GLOBIXS organization. As previously mentioned, the OWC's operators and their FASTTs will be interactively connected to the watchstanders of the other organizational building blocks listed here, and can be viewed as a collection of GLOBIXS anchor desks and other personnel assembled to suit the mission being executed. OWC personnel will be a part of, and served by, the CCC MAN, rather than a physically co-located structure. In other words, anchor desks of the GLOBIXS networks will be situated at each of the other organization building blocks. [Ref. 1:p. 5-4]

The *Space and Electronic Warfare (SEW) Center* will be responsible for strategic and theater-level SEW, and is planned to anchor GLOBIXS C, and will act as the interface between GLOBIXS C and the SEW TADIXS [Ref. 1:p. 5-5]. The SEW Center may also be delegated management functions of some or all TADIXS by the CWC [Ref. 1:p. 6-13].

The *Research Center* will anchor and provide information retrieval capability for the CCC through GLOBIXS F, the Data Base GLOBIXS. It will also house common data bases for the CCC MAN. [Ref. 1:p. 5-5]

The *Joint Intelligence Center* (JIC) will consist of the Fleet Intelligence Center (FIC), which will anchor GLOBIXS E, and act as the interface between GLOBIXS E and TADIXS imagery; the Fleet Ocean Surveillance Intelligence Center (FOSIC), providing operational intelligence (OPINTEL); and the Cryptologic Support Group (CSG), which will anchor GLOBIXS A and act as the interface with both SIGINT GLOBIXS and TADIXS [Ref. 1:p. 5-5]. Similarly, the *ASW Centers* will anchor GLOBIXS B and interface with both ASW GLOBIXS and TADIXS [Ref. 1:p. 5-5].

As shown in Figure 2 [Ref. 1:p. 8-1], the GLOBIXS and the CCC will comprise the shore side of information management in the COPERNICUS architecture. The final two

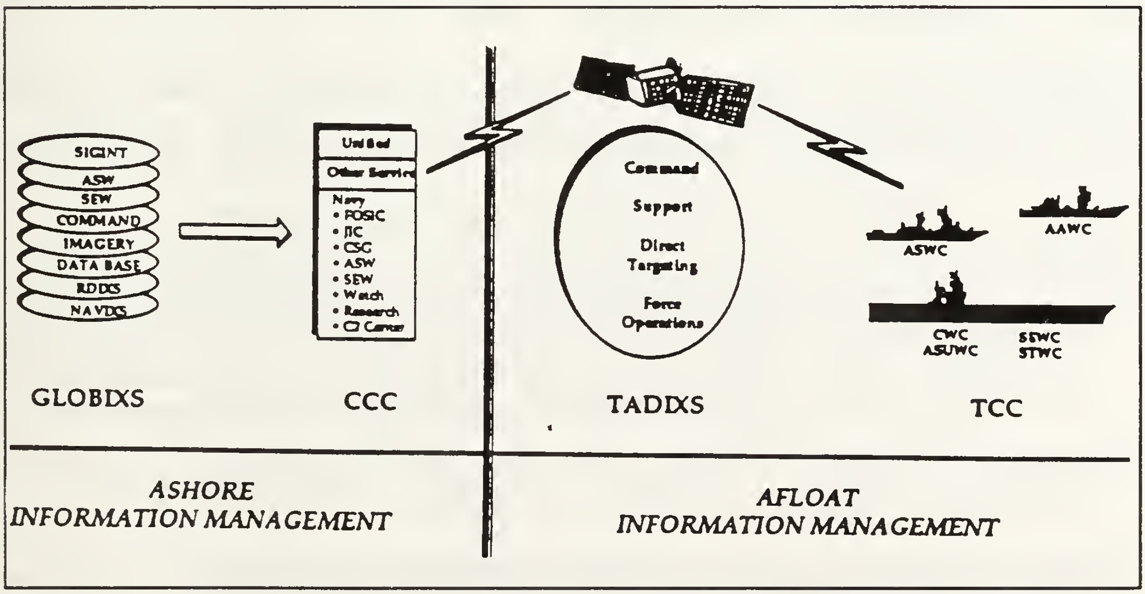

Figure 2. The Pillars of the COPERNICUS Architecture

pillars of the architecture, TADIXS and the TCC, will constitute the afloat/air/ground warfighting portion.

3. TADIXS (Tactical Data Information Exchange Systems)

a. Discussion

TADIXS are to be the virtual networks which will support afloat/ground/airborne Tactical Command Centers (TCCs). TADIXS are envisioned as information nets time-sharing communications circuitry over a broad range of *bearer services*, transmission media such as UHF, SHF, EHF and commercial SATCOM and HF. The information of one TADIXS may be supported by several channels and, conversely, one channel may support several TADIXS [Ref. 1:p. 6-1].

What percentage of time a TADIXS net will share with other TADIXS information and which medium will be used will be determined by the CWC, based upon the future NWP matrix previously discussed. The CWC may delegate the responsibility for management and control of the TADIXS to the SEW Commander (SEWC) or the SEW Coordinator [Ref. 2:p. 18].

TADIXS will be defined by five elements:

- *user software/data addressing*, HMI software will provide TADIXS information to the appropriate afloat commander. In turn, that commander will address the information to the cognizant afloat FASTTs requiring that information.
- *format*, either COPCOM or OPNOTE (digital), narrative message (textual), voice, or video
- *subscribership*, both GLOBIXS and TADIXS members designated as net subscribers

- *duration*, either permanent, or a specified time frame
- *communications pathway*, determined via the CSS, dependent upon available path, data format, degree of jam-resistance required, the capabilities of other TADIXS subscribers, and the duration of the TADIXS. [Ref. 1:pp. 6-14 - 6-15]

These capabilities will be afforded to TADIXS management by the CSS, which will provide the tactical transmission systems and the networking capabilities to support TADIXS communications services [Ref. 2:p. 5]. C S S will provide the ability for the CWC (through the SEWC) to control Copernican TADIXS in the same manner that other commanders control ASW, ASUW or AAW [Ref. 1:pp. 8-11]. CSS will be the framework for management of control of communications assets among TCCs. How this will be accomplished will be discussed in the next chapter.

The TADIXS will enhance communications among TCCs and augment command and control capabilities:

- by nearly eliminating the necessity for the narrative message through its use of binary data transfer (NAVIXS will still provide narrative message traffic);
- by providing greater efficiency and communications capacity by its virtual networking and the use of software which will provide information (via high resolution graphics and imagery) more efficiently and powerfully than text;
- by allowing multimedia access via the CSS; and
- by providing jam resistance capability. [Ref. 1:p. 6-4]

Some programs related to TADIXS development besides the CSS are the Advanced Narrowband Digital Terminal (ANDVT),

which supports secure digital voice or data communications; Submarine Satellite Information Exchange Subsystem (SSIXS) II, an upgrade to the current SSIXS UHF SATCOM network; and the UHF Follow-on (UFO) Satellite System, designed to replace FLTSATCOM satellites. [Ref. 1:pp. 6-15 - 6-17]

b. TADIXS Categories

All TADIXS, less NAVIXS TADIXS, are being designed in formats other than narrative messages [Ref. 1:p. 6-2]. Four types, or categories, of TADIXS are planned [Ref. 1:p. 6-1]:

- *Command* TADIXS. These multiformatted TADIXS will support communications among higher level commanders (National Command Authorities, Unified CINCs, FLTCINCs, CWC) and those between the CWC and his subordinate commanders (Navy, joint or Allied).

- *Support* TADIXS. These TADIXS will include, for example, Logistics, Environmental, Data Base File Transfer and Imagery TADIXS. NAVIXS TADIXS is contained here as well. NAVIXS is anticipated to be the only TADIXS to support narrative message traffic.

- *Direct Targeting* TADIXS. These TADIXS will be tailorable to specific geographic areas and can be modified for Allied usage.

- *Force Operations* TADIXS. These TADIXS will be constructed around the tactical force. Their makeup will be dependent on that force, whether it be Joint Task Force (JTF), Carrier Battle Group (CVBG) or Marine Air/Ground Task Force (MAGTF).

4. The TCC (Tactical Command Center)

A TCC will be defined by warfighting functions performed (e.g., CWC/OTC, SEWC, ASWC). Thus, one platform could have more than one TCC, and conversely, a single TCC

could be located on several platforms [Ref. 1:p. 7-5]. It will consist of the tactical centers of a battle group commander, his units and command centers (each of these also considered a TCC) of multiforce commanders whether afloat, ashore or airborne, thus providing connectivity among all of its members. TCCs will be hierarchically determined according to operational plans for a mission [Ref. 1:p. 7-6].

The future installation of LANs using fiber optic busses is intended to connect all operational spaces aboard ships [Ref. 1:p. 7-2]. These afloat LANs, using FASTTs with application software similar to their counterparts ashore, will receive information via the TADIXS. This enhanced capability within the tactical commander's ship and within the ships of his subordinates, as well as the ability to configure his C^2 system (receipt of external information) according to the needs of his mission, are expected to facilitate and improve his decisionmaking capacity.

The Navy Tactical Command System Afloat (NTCS-A) is related to the development of the TCC. It is to be composed of such systems as the Joint Operational Tactical System (JOTS); the Electronic Warfare Coordination Module (EWCM), which will provide planning, decision aids, and automated data processing support for the CWC/OTC and Electronic Warfare Coordinator (EWC); the Afloat Correlation System (ACS), a near-real-time support system for automated correlation, fusion and other analytical manipulation of multisource threat

information; and the Naval Intelligence Processing System (NIPS), which will support analysis packaging and distribution of intelligence information for the CWC/OTC and subordinate warfare commanders and coordinators. [Ref. 1:pp. 7-10 - 7-11]

Figure 3 [Ref. 1:p. 8-2] should assist the reader in

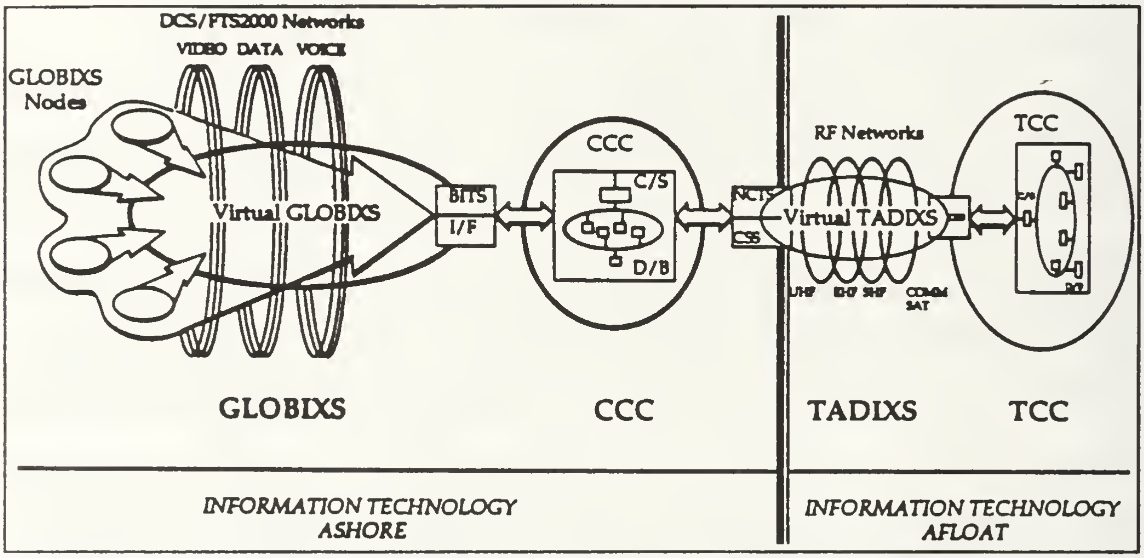

Figure 3. Conceptual/Physical Architectural Mapping

conceptualizing how the four pillars will interact technologically. The figure illustrates information technology ashore (GLOBIXS, CCC) and information technology afloat (TADIXS, TCC).

D. THE COPERNICUS C^2 DOCTRINE

The COPERNICUS architecture aims to provide the CWC information improved both in accuracy and in timeliness, affording him the precision, time and options representative of a C^2 capability commensurate with today's ever-improving

technology. Upon implementation of the COPERNICUS architecture, the four pillars, their features and capabilities will provide the tactical commander with six doctrinal choices to make according to his mission [Ref. 1:p. 3-1]:

- Selection of technological, doctrinal and organizational components of the TCC. That is, configuration of the TCC and the TCCs of his subordinate units to reflect the mission.

- Determination of which GLOBIXS information will be anchored by CCC personnel and which, if any, by his personnel afloat.

- Selection of desired GLOBIXS information by network and which cases (data precedences) will warrant receipt of that information. This option may be changed by the CWC in accordance with any changes in the mission.

- Selection of communications services and addressing them to chosen units and TCC positions.

- Selection of TADIXS mix: where information will be sent and how it will be displayed.

- Selection via CSS of communications resources to support the TADIXS virtual networks. [Ref. 1:p. 3-12 - 3-15]

As previously mentioned, some of these functions may be delegated to the afloat SEWC or even the SEW center ashore [Ref. 1:p. 6-13].

E. THE DEVELOPMENT OF COPERNICUS

In the next decade, the accomplishment of four tasks are required to begin achieving the COPERNICUS architecture:

- Build GLOBIXS and the analytical tools which will be used by the networks' users

- Formulate and format the right mix of TADIXS

- Construct the FCC, CCC and TCCs

- Systemize our [SATCOM] constellations, develop a dynamic multiplexing system, and incorporate DDN ashore to build the architecture's communications backbone. [Ref. 4:p. 92]

Additionally, planned TADIXS bearer services must be further developed so that they may provide the maximum amount of throughput [Ref. 1:p. 6-9].

Thus, the previously stated C^2 enhancements will be realized incrementally, in concurrence with development of the COPERNICUS architecture. COPERNICUS development will be achieved in steps by implementation of various related systems. CSS, the initial implementation of Copernican TADIXS, will be discussed in the following chapter.

F. SUMMARY

In order to achieve a cohesive C^4I architecture that will fully support C^2, the COPERNICUS architecture has been defined. COPERNICUS will be constructed as an interactive framework that ties together the command and control process of the Navy tactical commander afloat, the Joint Task Force (JTF) commander, the numbered fleet commander, and others with the CINCs ashore. COPERNICUS is intended to support all commanders, and will be delegated to the SEW Commander (SEWC) by the Composite Warfare Commander (CWC). COPERNICUS

development will be achieved in steps by implementation of various related C4I systems. CSS will be the initial implementation of Copernican TADIXS chapter.

III. THE COMMUNICATION SUPPORT SYSTEM (CSS)

A. THE CSS ARCHITECTURE

1. Discussion

CSS is more than a system. CSS is a communications sub-architecture that enhances battle force communications connectivity, flexibility and survivability through multi-media access and resource sharing. The CSS is to be an integral part of COPERNICUS. As shown in Figure 3, information will travel across the GLOBIXS, over the CCC MAN, and then to the CSS terminals located at TCCs via TADIXS. Conversely, information will travel from CSS terminals via TADIXS to the CCC MAN, then on to the GLOBIXS, thus providing the means for Copernican ship/shore ship communications. [Ref. 3]

Like COPERNICUS, the CSS architecture is also evolutionary: it will achieve full realization incrementally by integrating existing dedicated communications systems and by implementing new systems to interface with it. The CSS architecture will also provide direction to the design of those new systems [Ref. 5:p. 2-2].

The CSS modular approach will reduce development and life cycle support costs of future systems substantially by the use of open system architecture principles [Ref. 3]. An

open system architecture provides interoperability between an existing system and new technologies. Thus, CSS will provide flexibility through reconfiguration of either CSS hardware or software, and an expansion capability to support new technologies as well [Ref. 6:p. 36]. CSS intends to accommodate system improvements with minimal disturbance or adjustment to what has already been implemented [Ref. 5:pp. 2-2 - 2-4].

The CSS will be the first implementation of the COPERNICUS architecture and, in turn, the Navy EHF Communications Controller (NECC) will be the first increment of the CSS architecture, providing an EHF SATCOM capability to the Copernican TADIXS. Initial Operational Capability (IOC) of NECC under CSS is scheduled for FY94.

2. CSS Architectural Goals

The operational and procurement goals of the CSS architecture are in accord with those of the COPERNICUS architecture, and aim to provide the tactical commander with cost-effective C^4I capabilities necessary for proficient C^2 in the future:

- increased communications survivability via automated access for all users to multiple media, without sacrificing user throughput or communications efficiency;
- increased responsiveness to rapid changes in warfighting information transfer requirements by permitting near-real-time reconfiguration of communication connectivity to support changing priorities of information exchange;

- means for incorporating new communications capabilities without requiring changes to the user's baseband equipment or operating procedures;

- maximized use of existing communications equipment;

- minimum impact upon funding profiles of existing and planned programs;

- lower future communication system development and life cycle support costs; and

- simplified communication system operation and maintenance. [Ref. 5:pp. 2-2 - 2-3]

These architectural goals will be discussed in further detail at the end of this chapter.

B. DESCRIPTION OF CSS

1. CSS Components

In order to discuss the functional capabilities of the CSS, it is important to have a basic understanding of the components which make up the system. The following defined terms will enable the reader to better visualize the connectivity CSS will provide among Copernican TADIXS network members.

A CSS *user* is a communications device. A device may be a STU III for voice communications, a FASTT workstation, or a teletype (TTY). CSS and its users will be located at the CCC, the SEW Center, where the CSS GLOBIXS/TADIXS interface will be managed, and aboard TCCs.

A CSS *subscriber* is a device or software within CSS which interfaces directly between the user and the CSS

Standard Communications Environment Communications Services (SCE CS), providing one or more users access to the CSS [Ref. 5:p. 2-3]. (The SCE CS is a section of the CSS and will be described later in this chapter.) Using the previous example, a FASTT subscriber would allow a particular FASTT to interact with CSS; a TTY subscriber would allow a particular TTY to interact with CSS.

A CSS *service* will be able to accept/deliver incoming/outgoing information to a common community of subscribers [Ref. 8]. A service is similar to a circuit; however, it is defined by factors more in keeping with the activation of a TADIXS virtual network: the time period the service will be available; type of information, or operational format (digitized data, voice, imagery), which will be transmitted over the service and associated resources and access to these resources; security requirements; delivery characteristics of the service (time, degree of reliability, accountability); and the participants (subscribership) of the service [Ref. 7:pp. 5-6].

A CSS *resource* will consist of a CSS Subnet Access Control (SAC) segment, a CSS Link Access Radio Group (LARG), and the transmission medium to which the information is applied [Ref. 6:p. 33]. (Descriptions of the SAC and the LARG are included in the CSS Software Segments section.)

Resources are initially planned to provide data rates of 75 bps to 4.8 kbps. The NECC will operate at up to 2.4

kbps. Once additional SHF and commercial SATCOM terminals are fielded for the fleet, resources may provide up to 256 kbps [Ref. 8]; the incorporation of T1 rates (1.544 Mbps) into CSS operations is also planned for the future [Ref. 10].

2. Multimedia Access and Resource Sharing

CSS will allow one service to use more than one resource. This capability is termed *multimedia access.* Examples of this are a service that could be transmitted by one or more UHF SATCOM radios over several UHF frequencies, or a service that could be transmitted by one or more radios over separate frequency bands (e.g., EHF and UHF SATCOM). On the other hand, one resource may be used to support multiple services; this CSS function will be known as *resource sharing.* [Ref. 7:p. 7]

As shown in Figure 4 [Ref. 5:p. A-2], CSS will actually support four cases of *service-to-resource matching*:

- one resource supporting one service
- one resource supporting multiple services
- multiple resources supporting one service
- multiple resources supporting multiple services [Ref. 5:p. A-2]

It is planned that each service may be assigned to as many as eight different resources, and that up to 16 services may be allocated to a single resource [Ref. 6:p. 23].

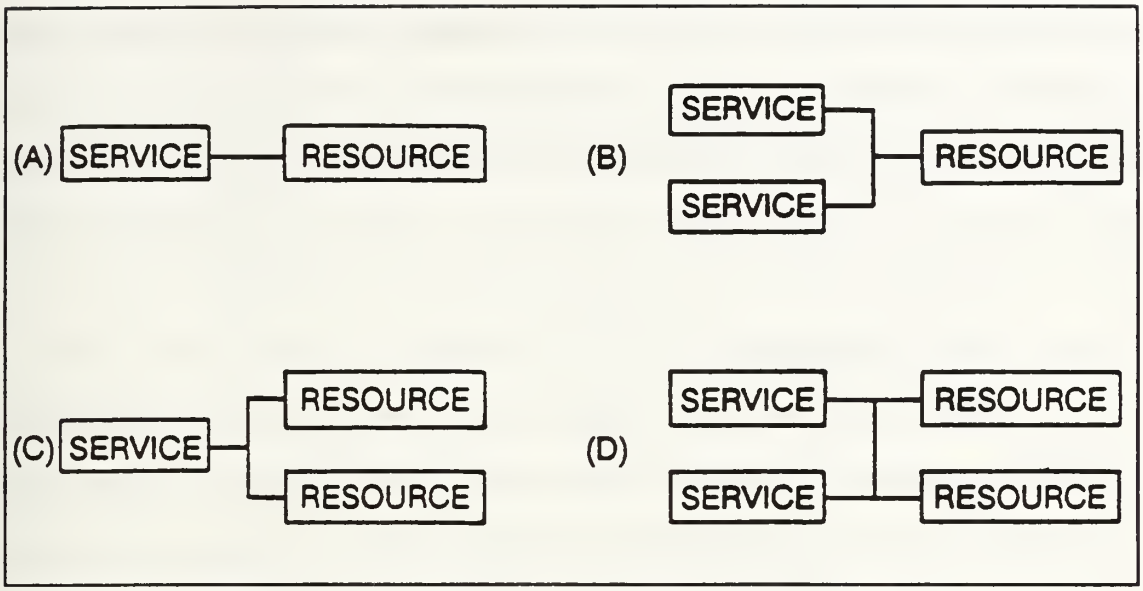

Figure 4. Matching Services to Resources

The amount of resource usage allotted to each service will be determined by the *service priority* , *data precedence* (COPERNICUS architecture documentation refers to data precedence as "case"), and *Percent Allocation of Resources (PAR)* values defined in a CSS connection plan (CNCTNPLAN) or entered by the CSS operator. The CNCTNPLAN will be derived from a matrix incorporated into a future version of the NWP that will define services based upon Joint doctrine, USCINC/FLTCINC OPLANs and communications plans (COMMPLANs) [Ref. 1:p. 6-3]. CNCTNPLANs will be discussed further in Chapter V.

Because of these values, new users within a TCC will be accommodated on a priority basis. No new radios should be required to support a new user unless the total capacity for a platform is exceeded [Ref. 7:p. vi]. However, if a

platform's capacity were to be exceeded, CSS would facilitate effective communications management by using the service priority, data precedence and PAR values. A more detailed description of how these values are used is included in the next section.

3. CSS Segments

CSS's major functions are software, not hardware, related [Ref. 9]. Familiarity with its segments and their functions will facilitate further understanding of CSS and how it will provide multimedia access and resource sharing. Therefore, an overview providing brief descriptions of the CSS segments follows.

a. The Hardware Segment

The *Communication Controller (CC)* segment is the physical multiprocessor computer base in which CSS functions will be executed. All software segments will physically operate in one or more computers using technology similar to, but not limited to, the DTC-2 series [Ref. 3]. (The DTC-2 is a workstation for the Naval Tactical Command System (NTCS)). The current standard is the 680X0 series of multiple processor computers [Ref. 8].

The number of CCs on a TCC, or platform, will depend on the platform's physical layout/available space, or perhaps its requirement to support both Special Intelligence (SI) and General Service (GENSER) information security

requirements [Ref. 7:p. 39]. If there is more than one CC on a TCC, there will be communication between the CCs to ensure that all of the TCC's resources are shared among subscribers [Ref. 7:p. 38].

Should CC failure occur, the TCC will have two options: continue to operate with the services established prior to CC failure; or revert to non-CSS operations, returning to nonvirtual circuitry through manual patching [Ref. 7:p. 38]. CSS-capable platforms will be able to communicate with non-CSS platforms (either US or allied). In these instances, however, a service will require a single, dedicated resource without the use of CSS protocols [Ref. 7:p. 7].

The CC will contain one or more central processing units (CPUs), memory, and input/output interfaces [Ref. 7:p. 43]. Additionally, the CC will have some hard disk storage capacity and be modularly expandable to support system growth [Ref. 7:p. 41].

b. The Software Segments

As mentioned earlier, CSS's success and the bulk of its design deals with each separate software function and the organization of those functions [Ref. 7:p. 37]. With the exception of the Link Access Radio Group (LARG), which consists of both hardware and software, the following segments

will comprise the CSS software. Figure 5 [Ref. 11] depicts how the software segments are linked.

The *Operating System/Inter-Process Communication (OS/IPC)* segment provides the operating system functions and communication between segments [Ref. 7:p. 7].

The *Subscriber Interface Control (SIC)* segment is the interface between the subscriber(s) and the CSS resource(s). Components of the SIC will provide data transport reliability and accountability, and perform resource selection, flow control and status monitoring procedures for a specific subscriber. A *Subscriber Data Unit (SDU)* is the amount of information that the subscriber treats as a logical unit. The SIC will receive, buffer, process (for reliability and accountability), and pass incoming SDUs from a resource to the subscriber; it will receive, process and route outgoing SDUs from the subscriber to the appropriate resource. If several resources have been assigned to a service, the SIC will continuously decide which resource to use for outgoing SDUs. Thus, if a resource were to malfunction, the SIC would send its SDUs to the other resource automatically with little, if any, disruption of communications. [Ref. 7:pp. 10-11]

The SIC will also perform internet routing. It will receive SDUs from one resource and automatically reroute them to another resource in order to reach a destination. This capability will provide connectivity between platforms that do not share common resources. [Ref. 8]

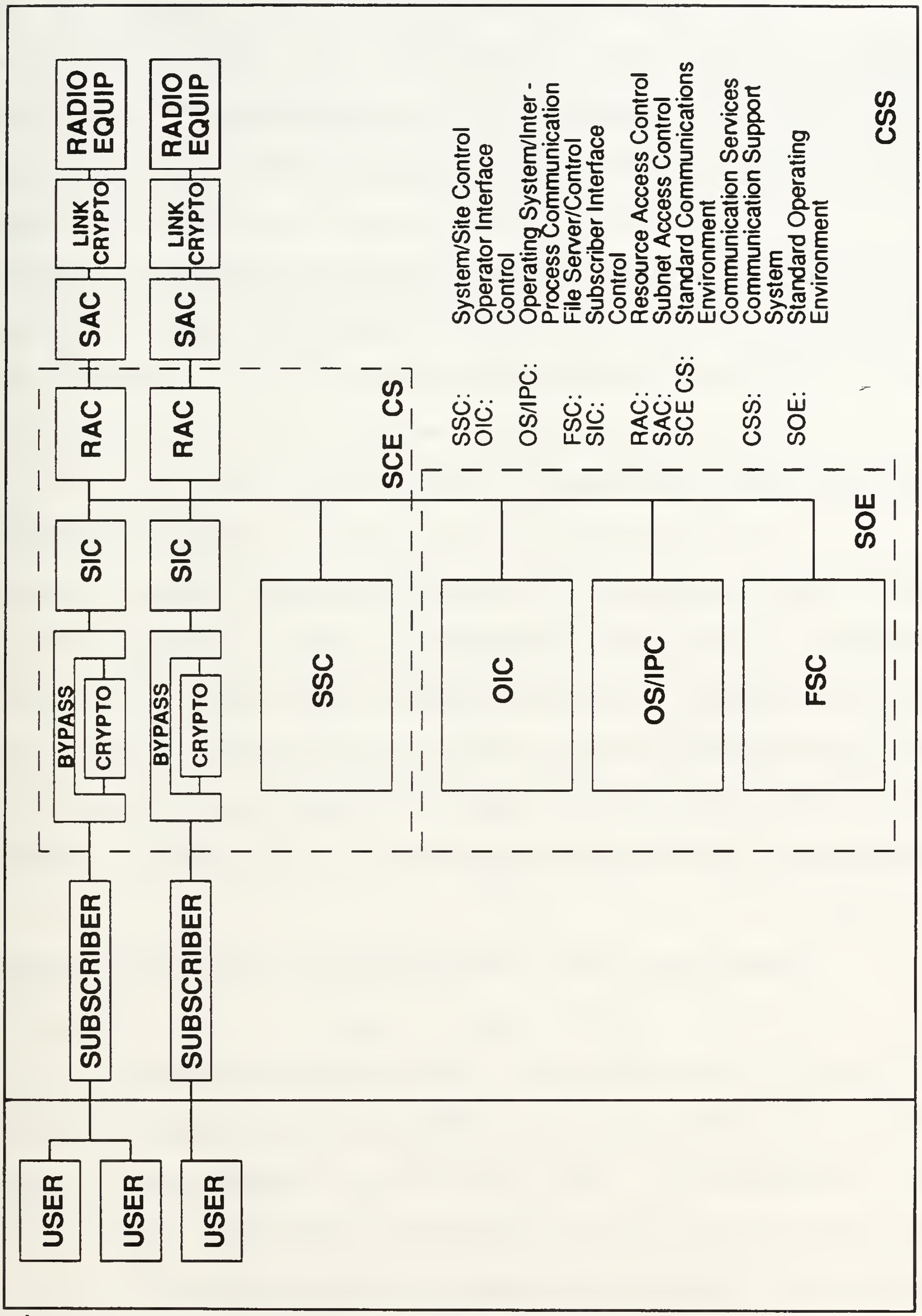

Figure 5. CSS Functional Partitions

The *Resource Access Control (RAC)* segment is the interface between SICs and the resource. There will be one RAC per resource. The RAC will send incoming SDUs received from a radio subnetwork to the proper SIC. It will also receive SDUs from the SICs and determine the appropriate order of transmission over the subnet. The RAC will provide status information to the SIC, including expected waiting times (by service) and the current subnet connectivity, allowing the SIC to choose the best transmission resource among those resources defined in the CNCTNPLAN for its use. [Ref. 8]

It is here where resource sharing is made possible. The RAC will maintain a transmit queue for each service. Selection of SDUs for transmission will be based on the *service priority*, *data precedence* and *PAR* values according to the CNCTNPLAN in effect. (The PAR parameter signifies the default percentage of the resource's transmission capability allocated to each service supported by the resource.) [Ref. 6:p. 26]

Each queue will be examined for service priority. The SDU with the highest service priority will **always** be selected for transmission. If several queues have equal priority, the algorithm for transmission selection in the RAC will determine the next SDU to be transmitted. The determination will result in either of two cases, depending on whether data precedence processing is being used:

- **Data precedence processing enabled.** When several queues have equal priority, the SDU with the highest precedence will be selected for transmission. If several queues have the same precedence, the highest priority/highest precedence SDU from the service which has not yet exceeded PAR will be selected. If neither queue has exceeded PAR, the oldest SDU with highest priority and precedence will be selected.

- **Data precedence processing *not* enabled.** When several queues have equal priority, the SDU from the service which has not yet exceeded PAR will be selected. If neither queue has exceeded PAR, the oldest SDU with highest priority SDU will be selected. [Ref. 6:pp. 25-27]

Figure 6 [Ref. 3] further illustrates resource sharing and multimedia access.

The *Subnet Access Control (SAC)* segment will exchange incoming/outgoing SDUs with the RAC, and will provide the transmission access control for a radio subnetwork [Ref. 9]. It will also provide other subnet management functions such as subnet activation and deactivation, and member entry and exit control [Ref. 8]. It will furnish to the operator the SAC's status, subnetwork's status, status of each network member, and the estimated delivery time to each member [Ref. 6:p. 25].

The *Link Access Radio Group (LARG)* is a combination of both hardware and software that provides link level encryption; modulation/demodulation; encoding/decoding; multiplexing; the radio; and antenna [Ref. 6:p. 33]. The SAC and the LARG, along with the transmission medium, constitute a CSS resource.

The *System/Site Control (SSC)* segment will be responsible for maintenance and dissemination of systemwide communication information and will enable a communications planner to match resources to services [Ref. 7:p. 12]. It will monitor the CSS hardware and software status and, with operator assistance, control the CSS hardware and software configurations whereby a new CNCTNPLAN may be designated [Ref. 6:p. 11].

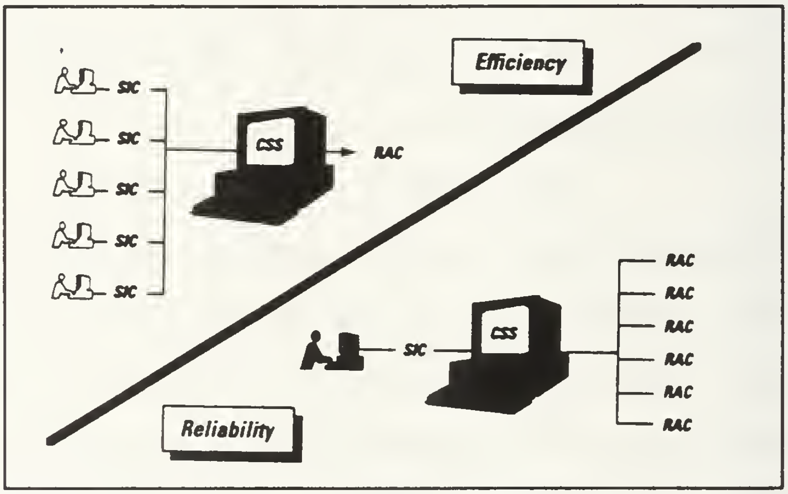

Figure 6. CSS Resource Sharing (top) and Multimedia Access (bottom)

The *Operator Interface Control (OIC)* segment will provide a display window using a standard X-Windows server and a keyboard/trackball operator input device [Ref. 8]. The OIC will accept commands from the operator, and will support the operator functions described in the next section. [Ref. 7:p. 12]

Finally, the *File Server/Control (FSC)* segment will provide storage and retrieval of information when required by other segments [Ref. 7:pp. 7-8].

c. The Standard Communications Environment Communication Services (SCE CS) and the SCE Standard Operating Environment (SCE SOE)

The SCE CS includes the SSC, subscriber level security, the SIC and the RAC. The remaining software segments make up the SCE Standard Operating Environment (SCE SOE): the OIC, the OS/IPC and the FSC. Figure 5 [Ref. 11] demarcates the SCE and SOE areas.

The CSS Standard Communications Environment Communication Services (SCE CS) has standard external interfaces (to the subscriber and SAC) and standard internal interfaces. In order for new radio subnets to function with CSS, their design must conform to SCE interface specifications. In this manner, new subnets may be added to, and be interoperable with, the SCE by connecting a new subnet's SAC and subscriber to a CSS RAC and SIC (respectively) via the standard SCE interface. [Ref. 8]

4. CSS Operator Functions

The OIC is designed as the interface between the operator and the CSS. On one platform, many operators could have access to the CSS, depending on the number of CSS workstations located on it (e.g., radio room operator, battle group communications planner). [Ref. 7:p. 28]

Since all operators will not be required nor need to know how to perform all CSS functions, operators will be

assigned different levels of access to CSS based on their duties and responsibilities. At each CSS site, the SOE will contain an access list with the name of each user, level of access, and password which will allow him/her access up to that level within the system. A person designated as the site's CSS system administrator would manage and maintain control over access to CSS. [Ref. 7:p. 28]

Automated network monitoring and management capabilities are provided by the CSS to assist operators in monitoring and controlling the real-time allocation of communications resources [Ref. 3]. The OIC will interface with the operator via the X-Windows display in the form of user friendly menus on the terminal's color monitor screens. The menus implemented will conform to the *User Interface Specifications for Navy C^2 Systems* [Ref. 12], which will standardize menu presentation for Human Machine Interface (HMI) users of both afloat and ashore FASTTs. The operator will simply select the option(s) he/she desires from the functions offered by the menu. As mentioned earlier, not all operators will have access to each feature. The main menu of the CSS console will provide the operator having authorized access and the proper permission level with the following options:

- CONNECTION PLAN. The main features offered here will allow the operator to select a CNCTNPLAN by file name from the platform's data base, view it, edit it, activate it if desired, or, if necessary, delete it from the data base.

- MONITOR. This feature will furnish the operator with the status of the system: inactive segment(s) will be identified; the current EMCON level and conditions will be indicated; a list of subscribers at the site and their locations may be given; access will be provided to SIC segments assigned to each subscriber; available and active resources will be identified and their current status will be indicated; test messages may also be run here in order to locate system errors.

- MAIL. This function is similar to electronic mail (E-mail), and will allow informal coordination among terminals located on a TCC, or with other CSS platforms. This feature will be very helpful to platforms for coordinating the initial CNCTNPLAN configuration and when subsequent reconfigurations are required.

- REPORTS. This attribute will provide its information to the operator in either graph or textual form. Information will consist of performance statistics: the current transmission status, the number of SDUs submitted, the transmission rate, and the average queue time. Additionally, a day file, or journal, will automatically log the commands performed by an operator in a 24-hour period.

- SYSTEM MANAGEMENT. This particular function will be available only to authorized personnel with the appropriate password. Capabilities residing here are: *Configure Hardware*, to provide CSS the site's current hardware configuration; *Configure Site*, to provide CSS the site's current software configuration: *Network Management*, to review current workstations, add/remove workstations, run LAN diagnostics, check network status; *Operator Access*, to list operators, access levels, passwords; *Backup System*, to create a backup for the data base; *Recover System* to restore a site's data base from a backup; *Update Software*, to load new software when upgrading a software segment; *Restart System*, to resolve, for instance, timing problems (this option will be selected in extreme circumstances only, since this would result in halting all site communications); *Shutdown System*, to terminate all CSS operations on a platform (usually during maintenance/long inport periods).

- UTILITIES. Capabilities offered for the operator's personal use will be a calculator, scratch pad, a logout option, selection of display attributes, and the ability to change the password of his/her own account.

- APPLICATIONS. This section will allow the operator to enter a TADIXS network from the CSS operator's console, converting it to a service workstation. [Ref. 7:pp. 28-35]

Operators will be alerted to any resource losses or equipment malfunctions, and will be advised when action is required to resolve the problem [Ref. 6:p. 14].

C. CSS CONTRIBUTIONS TO C^2

Service-to-resource matching to support the TADIXS networks will become more enhanced as CSS progresses toward complete implementation, incorporating the entire range of TADIXS bearer services (transmission media) envisioned: HF, VHF, UHF Line-of-Sight (LOS), and all SATCOM.

UHF, SHF and HF are said to be the frequency spectra that have the greatest potential for near term contribution to Copernican communications [Ref. 1:p. B-3]. EHF SATCOM, however, is important because of its jam resistance. EHF SATCOM is also the first Copernican TADIXS bearer service that will be accessible through the CSS. This will be made possible by the NECC.

Because of the extensive usage of UHF SATCOM systems and the Navy's investment of both time and dollars in the development of current UHF SATCOM systems, it is hoped that these systems will be made CSS-compatible as soon as possible. Efficient UHF SATCOM TADIXS services are envisioned by the author as capable of both UHF Demand Assigned Multiple Access

(DAMA) and CSS operations. The advent of the Tactical Intelligence Subsystem (TACINTEL) II Plus (shortly after NECC) should be the first step toward DAMA/CSS application, providing increased throughput and a multimedia capability to TACINTEL operations [Ref. 10].

1. The COPERNICUS Architecture

Multimedia access and resource sharing will permit the evolution of TADIXS and TCC operations within the COPERNICUS architecture. They are the CSS features that will allow the tailored configuration of a tactical commander's C^2 system discussed in Chapter II.

Selection of communications services, TADIXS mix, and communications resources will be accomplished via activation by designated TCCs of a CSS CNCTNPLAN chosen by the tactical commander or SEWC (to whom this duty may be delegated). The CNCTNPLAN itself will be based on the yet-to-be developed NWP matrices. The CSS will empower communications planners with the ability to prescribe service priority, data precedence (case) and PAR to the communications services which will support the mission.

2. CSS Architectural Goals

Now that the reader has been provided with a working knowledge of the system, the CSS Architectural goals will be discussed in further detail.

a. *Increased Communications Flexibility and Survivability via Multimedia Access*

Increased communications flexibility and survivability via multimedia access will be accomplished without sacrificing user throughput or communications efficiency by allowing a TADIXS network to be restored on another resource (different radio). Users will be able to maintain uninterrupted communications over several resources without operator intervention [Ref. 9]. This means that in the event of the loss of one resource, high priority services will automatically continue operating over their other assigned resources.

As an example, a UHF SATCOM network can currently experience hours of degraded communications or total loss of communications because its assigned channel is experiencing interference or jamming, and because there is no other available channel on which to restore the network. However, once CSS is fully implemented, if a UHF SATCOM channel were to be jammed, multimedia access would allow the TADIXS networks supported on that channel to continue operating on another UHF SATCOM channel, or other media automatically. (Capabilities available at the IOC NECC will be discussed in Chapter IV.)

b. Increased Responsiveness to Rapid Changes in Warfighting Information Transfer Requirements

Additional flexibility through fleetwide reconfiguration may be achieved by the activation of a new CNCTNPLAN: different subscribers; a new TADIXS mix; reallocation of resources--using different, additional, or fewer resources; and different service priority, data precedence (case) and PAR values. If a battle group's mission were to change, the CWC or SEWC would coordinate the designation of a new CNCTNPLAN and its activation with the FLTCINC and CCC/SEW Center personnel. The contents of the new CNCTNPLAN would be readily available to all concerned, simply requiring retrieval from each data base.

Similarly, additional flexibility through reconfiguration may be achieved when authorized personnel make changes at a more localized level. For instance, the units in a Marine Amphibious Readiness Group (MARG) may collectively need to change ship/shore frequencies to enhance operations. In both instances, CSS will significantly decrease planning, configuration, and network activation time, thereby increasing communications' responsiveness to a battle group's information transfer requirements.

c. Means for Incorporating New Communications Capabilities

Incorporating new communications capabilities without requiring changes to the users's baseband equipment or operating procedures will be accomplished by the CSS SCE specifications. As mentioned earlier, new systems will connect into the CSS with their SACs, SICs and subscribers designed to SCE CS specifications. This method of adding new, interoperable systems to the CSS should also result in minimum impact upon funding profiles of existing and planned programs, and lower future communications system development and life cycle support costs [Ref. 5:p. 2-2].

d. Maximized Use of Existing Communication Equipment

With the full, or even partial, implementation of CSS, use of existing shipboard communication equipment and assets should be maximized by faster, more efficient throughput of digital data. Communications equipment (resources/radios) currently dedicated for one purpose (e.g., CUDIXS, OTCIXS) will no longer sit idle during periods of nontransmission. Other CSS services could use resources during those periods.

Assets such as UHF SATCOM channels should ultimately be capable of supporting various TADIXS nets, instead of one channel being limited to supporting one network (e.g., CUDIXS) as is done today. Whereas today's operational

requirements vie for scarce UHF SATCOM channels, it is not unreasonable to say that many valid requirements presently unsatisfied may be accommodated in the future under their respective TADIXS categories.

e. Simplified Communication System Operation and Maintenance

As pointed out in the Operator Functions section in this chapter, CSS will facilitate operation and management of TCC communications assets. CSS plans to provide a useful flow of information to SEWC staff personnel and, in turn, allow transmission of concise direction to TCC platforms from the SEWC staff personnel. It is also the intention of CSS to identify system problems and advise operators of corrective actions early so that CSS Mean Time to Repair (MTTR) will be considerably enhanced. [Ref. 5:pp. 4-2 - 4-3]

D. SUMMARY

CSS is not only a system, but an architecture with C^2 enhancement goals similar to those of COPERNICUS: increased communications flexibility, survivability, efficiency, reliability, increased responsiveness of communications systems, and maximized use of existing communication equipment. Multimedia access and resource sharing are the means by which CSS can achieve these goals.

An open system architecture will facilitate addition of new systems to interface with CSS. Systems designed to SCE CS

design specifications may be added to the CSS, thereby permitting use of CSS resources.

IV. THE NAVY EHF COMMUNICATIONS CONTROLLER (NECC)

A. EHF COMMUNICATIONS TODAY

EHF communications came to be developed under the Military Strategic and Tactical Relay System, Milstar, a joint program designed to provide survivable, antijam, interoperable EHF satellite communications among the services [Ref. 13:pp. 49-51]. The recent conclusion of the Cold War has led to a reevaluation of Milstar. Whereas the majority of Milstar's circuits previously were planned to support strategic requirements, a more tactical emphasis has now been placed on the system. Tactical users now stand a chance of greater system usage.

In addition to the Milstar satellites, the Navy also has Fleet EHF Packages (FEPs) on FLTSATCOM (FSC) satellites 7 and 8 and UHF Follow On (UFO) satellites 4 through 9 [Ref. 1:p. 4-25]. The Navy EHF Satellite Program (NESP) terminals (AN/USC-38), are planned to be installed on designated ships, submarines and shore sites, with an IOC in FY93.

Because of its original objective, Milstar stressed survivability over capacity: throughput was intentionally sacrificed in order to ensure protection from physical attack, low probability of interception, secure encryption, and very high resistance to jamming [Ref. 13:pp. 51-53]. Consequently,

present EHF SATCOM programs support only low data rate (LDR) circuit operations (up to 2.4 kbps) [Ref. 1:p. 8A-12].

The Space and Naval Warfare Systems Command, COMSPAWARSYSCOM, is currently designing a medium data rate (MDR) capability (up to 1.544 Mbps) which, once developed, may support the Copernican GLOBIXS [Ref. 1:p. 8A-12]. This capability, however, will not be available at IOC; only EHF LDR communications will be supported at that time.

B. THE NAVY EHF COMMUNICATIONS CONTROLLER (NECC)

Under CSS, the Navy EHF Communications Controller (NECC) will provide the bearer service, *EHFIXS*, to NESP terminal platforms. The NECC will be installed with selected NESP terminals on both afloat (TCCs) and shore sites (NCTAMS, CCCs). Due to funding limitations, not all NESP terminal installations will be accompanied by NECC installations initially.

It is anticipated that six LANTFLT ships and one LANT shore site will receive NESP/NECC installations first [Ref. 13]. This number should be sufficient for initial TCC/shore site communications, creating an interim operational period during which new uses can be ascertained, problems resolved, and procedures developed. If wisely used, this interim period can facilitate the transition to fleetwide NECC operations.

1. System Description

In order to differentiate between the increments of the CSS architecture (of which the NECC is a project, or increment) and the incremental capabilities of the projects themselves, the systems' designers refer to project increments as *builds* [Ref. 14:p. 1]. For example, NECC Build One will be available for use in FY94 [Ref. 10]. Since the purpose of this thesis is to discuss operations at NECC IOC, the remainder of this chapter will address only NECC Build One. The Appendix [Ref. 15:pp. 110-112] provides a list of all capabilities planned for NECC Builds One and Two.

The NECC Build One user community will include Tactical Data Processors (TDPs). (For clarification, TDP is the Joint Operational Tactical System (JOTS) application software used normally on a DTC-2 terminal. TDP also refers to the Tomahawk Weapons Control System (TWCS) and Mission Display System (MDS). A terminal using TDP software is often referred to as a TDP.) The NECC will interface with EHF SATCOM equipment (a standard CSS resource) and UHF SATCOM equipment (a nonstandard CSS resource), providing these bearer services to the users [Ref. 15:p. 1].

UHF SATCOM will *not* be considered a NECC resource in the CSS sense [Ref. 15:p. 14]. In order for a TDP to maintain backward compatibility with current OTCIXS and TADIXS A operations, an interface will be installed to permit continued communications over the UHF SATCOM OTCIXS and/or TADIXS A

networks by the NECC-TDP subscribers [Ref. 15:p. 28]. (UHF TADIXS A is *not* to be confused with Copernican TADIXS.)

NECC Build One will be responsible for the following segments, some of which were described in the previous chapter:

- The Hardware Segment, or Communications Controller (CC);
- The CSS Standard Communication Environment (SCE), which will provide configuration and monitoring, data transport, multimedia selection and access, and resource sharing. The SCE will consist of the System Site Control (SSC), subscriber level security, the Subscriber Interface Control (SIC), and the Resource Access Control (RAC);
- The CSS Standard Operating Environment (SOE), which will provide the operator interface, real-time multiprocess and multiuser operating system, and communications between processes (software segments). The SOE will be comprised of the Operator Interface Control (OIC), the Operating System/Inter-Process Control (OS/IPC), and the File Server/Control (FSC);
- The Connection Plan Generator/Security Manager (CPG/SM);
- The EHF Subnet Access Controller (SAC);
- The EHF Manager;
- The TDP Subscriber; and
- The Advanced Narrowband Digital Voice Terminal (ANDVT) SAC. [Ref. 15:pp. 24-25]

Discussions on each segment not described earlier follow. Figure 7 [Ref. 14:p. 3] is a proposed block diagram of the NECC at Build One. (The *Navigation Data Source* in the figure will be located in the NECC data base and will provide a site's position to other sites in support of EHF transmissions [Ref. 17].)

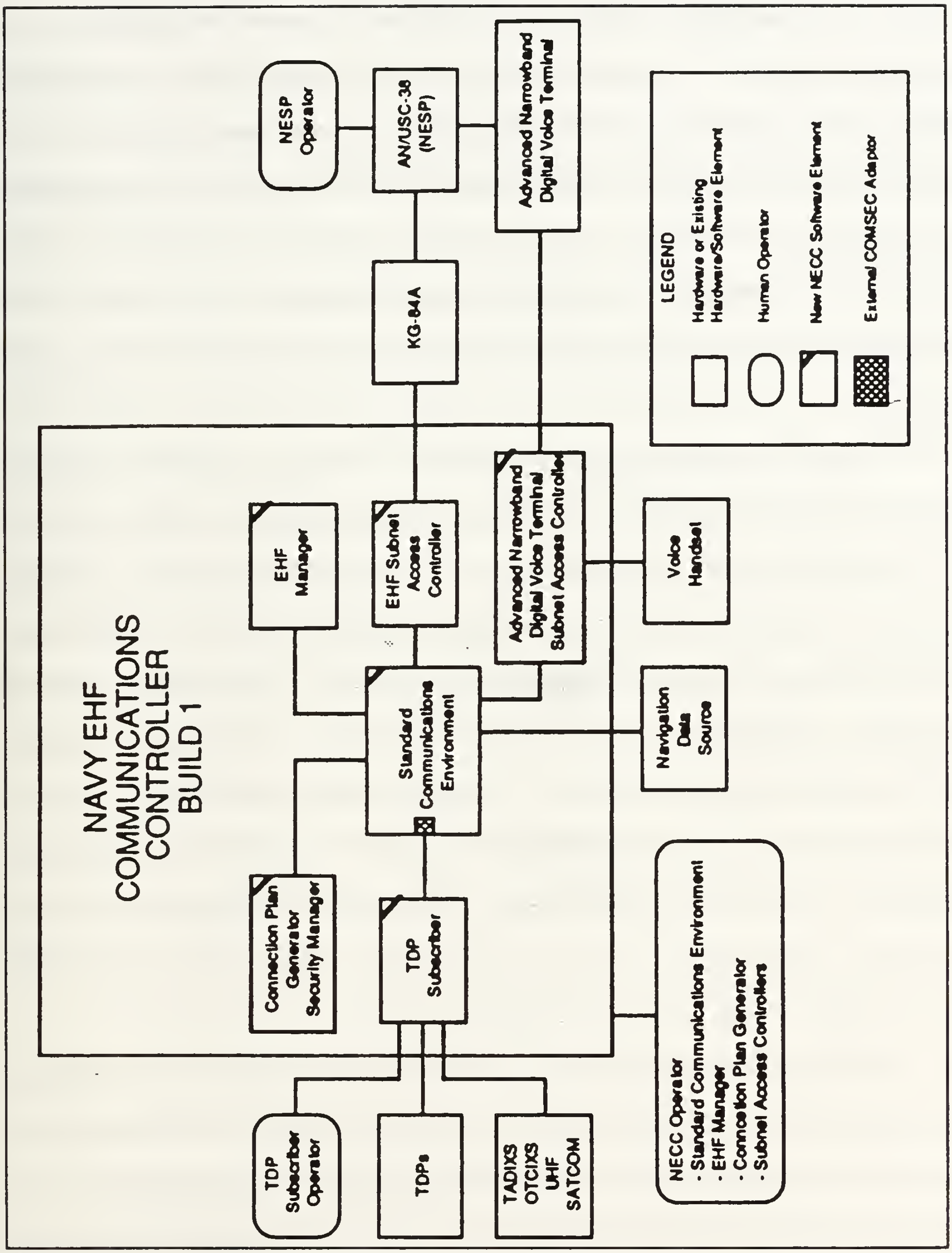

Figure 7. Conceptual NECC Build One

The *Connection Plan Generator/Security Manager (CPG/SM)* will provide operators the ability to generate and

tailor a connection plan (CNCTNPLAN), and to transfer the connection plan to other sites [Ref. 15:p. 36]. Different levels of these capabilities will be made available to CSS operators, depending on their Copernican function: the theater planning site (such as the CCC), the CWC's (or numbered fleet commander's) site, or simply an operational site (TCC). The reader will become familiarized with CNCTNPLANs in the next chapter.

At the planning site, theater and site CNCTNPLANs will be generated, received, stored and distributed; NECC software will be received from a software maintenance activity, stored, distributed and managed; and key requests may be generated. At the site of the battle group commander, CNCTNPLANs will be received, stored, edited and distributed, and NECC software may be received and stored. Operational sites will receive and store both site CNCTNPLANs and NECC software. Controlled access to the NECC data base for CNCTNPLAN generation and software distribution management will exist at all sites. [Ref. 15:p. 36]

The *EHF Subnet Access Controller (SAC)* will perform the SAC functions described in Chapter III by allowing an operator to manage the EHFIXS subnetwork. The EHF SAC will also interface with the CSS SCE so that the SCE may access the transmit and receive capabilities of the EHF SATCOM circuits. [Ref. 15:pp. 24, 32]

The *EHF Manager* will assist the NECC operator in the planning and management of EHF circuits [Ref. 15:p. 25]. It will allow the operator to plan EHF circuit configurations and evaluate how those configurations fit within the constraint of available NESP terminal resources and satellite assets. It will keep track of resources and assets used by EHF services and will attempt to fit additional requirements into the remaining resources and assets. If availability or coverage problems exist, alternate configurations will be presented. If there are no feasible alternatives, the operator will be notified. [Ref. 16:pp. 13-14]

The EHF Manager will present information to the operator regarding EHF subnet configurations based on EHF satellite coverage, capacity requirements, available payload, and NESP terminal resources. NESP terminal configuration information, based on the EHF circuit requirements entered and existing terminal resource constraints, will also be displayed. [Ref. 15:p. 38]

The *Tactical Data Processor (TDP) Subscriber* will provide an interface between TDP terminals and the NECC via the CSS Communications Controller (CC) without the need for any modification to the TDP terminal itself. It will maintain backward compatibility with the UHF SATCOM resources that the TDPs use, offering three options for transmission of NECC-TDP information: the user will be able to send his/her information via UHF SATCOM, EHFIXS, or over both media. At TADIXS gateway

shore sites, the routing decision will be made at the *TADIXS Gateway Processor*. EHF communications via the NECC-TDP Subscriber will be similar to those currently used by TDPs for UHF OTCIXS/TADIXS A network communications. [Ref. 15:pp. 24,28]

The *Advanced Narrowband Digital Voice Terminal (ANDVT) SAC* is intended to permit shared voice and data usage of a resource formed by the ANDVT and EHF service. The ANDVT SAC is *not* funded at this time. NECC Build One will not include an EHF SATCOM voice capability. However, EHF ANDVT communications will be possible among NESP terminal users without the use of NECC. Once funded and installed, the ANDVT SAC could provide a secure voice capability among NECC users. [Ref. 15:pp. 33-34]

2. Other Capabilities

As would be expected, the NECC will provide EHF multimedia access and resource sharing. NECC resource sharing will include the CSS algorithm defined by the current SCE specifications. Thus, use of EHF resources will be based on the service priority, data precedence and PAR assignments designated by the SEWC staff in the CNCTNPLAN.

NECC Build One will also provide many of the CSS operator functions described earlier in Chapter III: accountable data transport service, embedded training; on-line documentation; alerts; help; subscriber level security; day

file journal; CNCTNPLAN retrieval and conversion to a site configuration; site configuration edit and activation; site configuration display; automatic software-to-hardware assignment; EHF SATCOM subnet selection; EHF SATCOM subnet access sharing; operating system support for the NECC segments; operator interface support; file services; and data base services [Ref. 15:pp. 29-31].

The *Embedded COMSEC Adapter (ECA)*, or External KG-84 Adapter, will provide subscriber level encryption. It will be used within the NECC to separate the NECC subscriber and the SCE, and will provide a trusted bypass for control information transfer between the subscriber and the SCE [Ref. 15:p. 44].

Figures 8 and 9 [Ref. 14:pp. 26-27] illustrate proposed shore TADIXS gateway and shipboard site configurations. Both configurations show the TDP subscriber linking the CSS SCE, the TDP terminals and the UHF resources (the ON-143, UHF SATCOM interconnecting group and the TD-1271, UHF DAMA multiplexer). ANDVT SACs are included in both figures. The shore gateway configuration includes the TADIXS Gateway Processor. In the shipboard configuration, TWCS and JOTS TDPs are depicted.

C. NECC APPLICATIONS

Until a wider range of services can be fully integrated into the CSS (other SATCOM, UHF LOS) and the NECC (voice, TTY), and before an EHF MDR capability is developed, the CSS

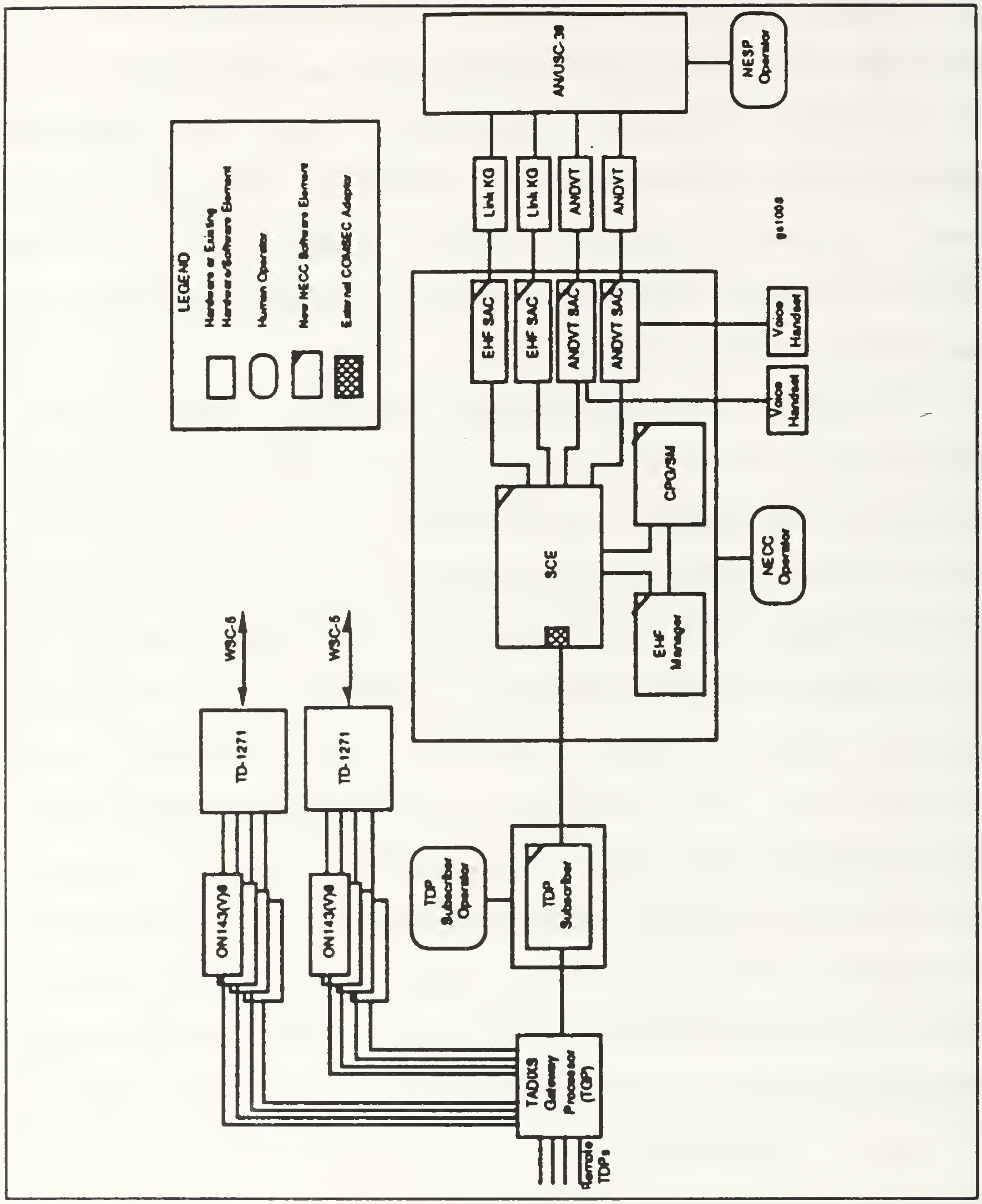

Figure 8. Conceptual Shore Gateway Site Configuration (NCTAMS)

will not function as discussed in the previous chapter. Initial NECC operations will provide multimedia access and resource sharing among EHF services and resources only. It is

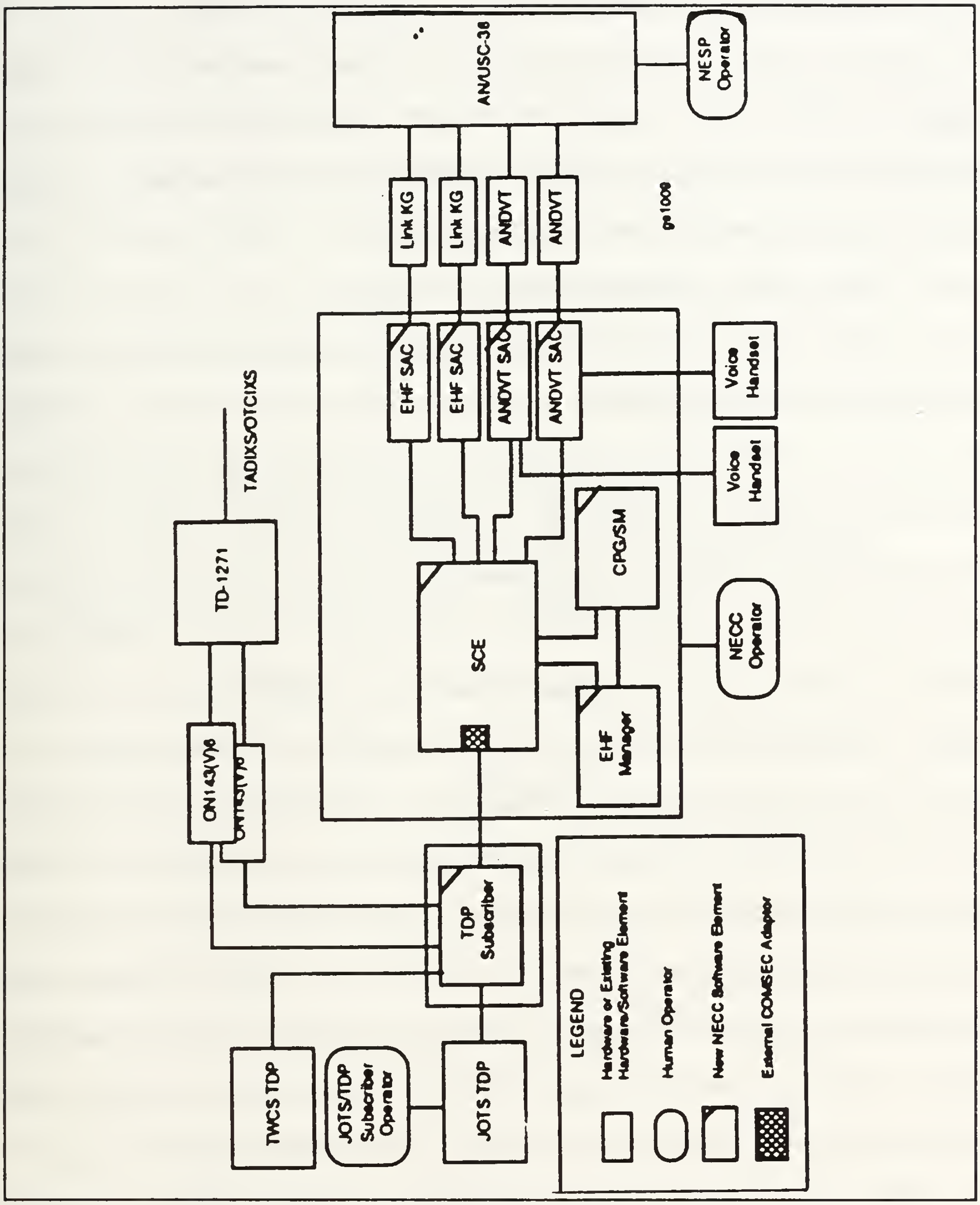

Figure 9. Conceptual Shipboard Site Configuration

imperative that both UHF and SHF SATCOM, as well as other bearer services, be made standard CSS resources as quickly as possible in order to provide increased communications

survivability and flexibility in support of C^2. The ANDVT SAC, which could provide NECC a voice capability, is not funded at this time. If it is not feasible to incorporate ANDVT voice communications into NECC, it must be incorporated into CSS via some other CSS resource.

1. Near Term Applications

In the near term, however, NECC will provide considerable enhancements to operations and communications management. NECC will, in effect, offer the prototype Force Operations TADIXS, intended to support Strike Warfare, ASW, AAW and ASUW. TADIXS A broadcasts critical Over-the-Horizon Targeting (OTH-T) information to tactical units in support of Strike Warfare, Anti-Surface Warfare (ASUW) and Anti-Air Warfare (AAW) missions. OTCIXS supports acknowledgment of receipt of mission-critical TADIXS A information and ship-to-ship/ship-to-shore OTH-T transmissions. A separate OTCIXS link enables Submarine Operating Authorities (SUBOPAUTHs) to transmit OTH-T information to submarines, and enables the transmission of oceanographic and meteorological information as well. Both networks support NTCS communications and permit communications between NTCS users and other TDPs, such as those used by the Tomahawk Weapons Control System (TWCS). [Ref. 15:pp. 85-94]

The addition of an EHF capability to the TADIXS A and OTCIXS networks will improve C^2. EHF will afford these

networks a higher degree of resistance to jamming and OTH-T communications outages.

The additional EHF OTCIXS and TADIXS A will also provide those UHF networks some redundancy. The resultant flexibility might relieve some of the dilemmas that periodically face communications managers and users today. There are three areas where this flexibility might prove useful:

- Restoral of UHF networks using EHF;
- Reduction of traffic loading on UHF networks; and
- Support of no-notice UHF requirements.

a. EHF Restoral of UHF Networks

Should either the UHF OTCIXS or TADIXS A suffer outage or degradation due to intentional jamming or unintentional interference, NECC user network operations could continue on EHFIXS. Partial EHF restoral by only those platforms with NECC would ensure that key players continued to transmit and/or receive vital information. This information could then be passed to non-NECC platforms via other means (e.g., voice, orderwire). If UHF communications were lost aboard a NECC-equipped ship, EHF OTCIXS and TADIXS A communications would continue.

Shore stations would benefit as well during UHF satellite or some UHF equipment outages. A TADIXS A keying

station could still transmit EHF TADIXS A if it were NECC-equipped; a NECC-capable TADIXS gateway could continue operations over EHF SATCOM.

b. Reduction of UHF Network Traffic Loading

EHFIXS could be used to reduce loading during heavy UHF OTCIXS traffic periods. NECC subscribers could use the EHF network to receive and transmit their messages, thus lightening the load on the UHF channel and allowing more rapid delivery of message traffic.

c. Support of No-notice UHF Requirements

Emergency activations of UHF circuits could be supported. For instance, a UHF DAMA slot could support a sudden high priority requirement if NECC UHF TADIXS A and/or OTCIXS users temporarily shifted to EHFIXS operations. Such operations would continue until the UHF DAMA slot were released back for its original use. Although this procedure would result in restoral for NECC users only, it might save a network from total preemption by the higher priority requirement. This capability could also be used to support lesser priority theater requirements, such as exercises, at the discretion of the FLTCINC.

As shown above, even partial execution of these restoral methods by NECC-equipped platforms would contribute a greater flexibility to fleetwide communications. Often, a small amount of flexibility is all that is required to resolve

SATCOM emergencies and short-fused requirements. As additional systems are incorporated into CSS and NECC, communications flexibility can only increase.

2. Future Applications

Some possible applications for NECC in the future include: expanded Strike Warfare communications support, for example, the transmission of Tomahawk mission planning material (MPM) via Mission Data Updates (MDUs) to Afloat Planning Systems (APS) aboard carriers; intelligence and imagery support; communications services between AAW and ASUW subscribers; and Surveillance Direction System (SDS) communications in support of ASW. [Ref. 15:pp. 85-93]

EHF SATCOM continues to be the most jam-resistant of all satellite communications. In order to maximize use of the Navy EHF communications system and CSS, and to provide optimal capability to Navy C^4I, MDR EHF design and development must continue to completion and be incorporated into the NESP terminal to operate with NECC for future use of satellite MDR capability once it becomes available on Milstar.

D. SUMMARY

Due to the previous emphasis on survivability, the NESP terminal (IOC 1993) will initially support circuits of up to 2.4 kbps. A MDR capability is being developed by COMSPAWARSYSCOM.

The NECC will be the first communications system to operate under CSS and, in conjunction with the NESP terminal, will bring EHFIXS to NECC-capable Tactical Data Processor (TDP) sites. At NECC IOC (1994), additional communications flexibility will be provided in support UHF network restoral, UHF network traffic loading, no-notice UHF requirements. In order to enhance jam-resistant EHF SATCOM, MDR development should continue to completion.

V. CSS/NECC PLANNING AND MANAGEMENT AT IOC

A. INTRODUCTION

The Naval Ocean Systems Center (NOSC) [Ref. 7] provides an approach to CSS communications planning. The first planning stages in the development of an individual CSS site's connection plan (CNCTNPLAN), based on a FLTCINC communications plan (COMMPLAN), will be discussed here. The discussion is based on the approach, using the services and resources provided by NECC together with the NESP terminal at IOC.

Many possibilities exist in the development of a CNCTNPLAN: parameters such as service priorities and PARs may vary from theater to theater, from operation to operation, from one platform to another, or even from one time period to another. A simple case will be discussed here in order to point out how the parameters might be used to define a CNCTNPLAN. Managerial issues will be discussed as they arise, and any difficulties encountered in the process will be identified. Recommendations are proposed throughout the procedure. It is hoped that the reader will better understand these parameters for planning purposes, and that he/she will gain an appreciation for the configuration possibilities that both CSS and NECC offer.

B. CSS COMMUNICATIONS PLANNING APPROACH

As mentioned earlier, CNCTNPLANs will be based on matrices of a future NWP, and those matrices will be derived from existing Joint Doctrine, theater OPLANs, and COMMPLANs within a FLTCINC's Area of Responsibility (AOR). It is anticipated that the development of a CNCTNPLAN for a TCC will be a top-down procedure, starting at the FLTCINC level with general guidance provided in the form of CSS COMMPLAN requirements, then working down to the numbered fleet and battle group commanders. Lower command levels will review the COMMPLAN information upon receipt for feasibility and add more detailed information, such as frequencies and smaller networks or network members. The completed COMMPLAN will then be sent to individual ships for implementation. Figure 10 [Ref. 7:p. 20] illustrates proposed planning functions at the various command levels. [Ref. 7:pp. 20-21]

It is intended that information be entered into the CSS COMMPLAN at the highest level that information is known [Ref. 7:p. 21]. For example, the numbered fleet commander or battle group commander might designate a UHF line-of-sight (LOS) or HF service to support carrier flight operations and assign to it frequencies obtained from the NCTAMS.

It is recommended that close coordination with the Naval Computer and Telecommunications Area Master Station (NCTAMS, formerly NAVCAMS) be conducted by *all* command levels in order to confirm CSS COMMPLAN feasibility and to determine if there

are any requirements for shore site involvement. The participation of the NCTAMS in the planning process within its COMMAREA is highly valuable because it often provides much insight and assistance to commanders both ashore and afloat.

It is intended that the first planning step in the development of a CSS COMMPLAN will include the following procedures:

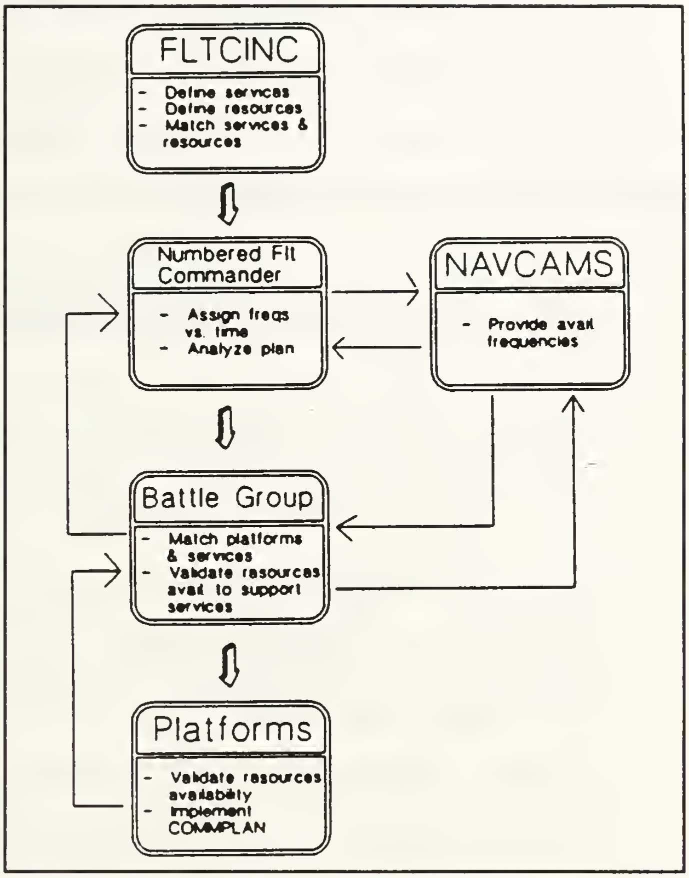

Figure 10. Proposed CSS Communication Planning

- *set up services*, by matching specific operational requirements defined by the FLTCINC to appropriate services in order that each resource requirement be defined;

- *set up resources*, by identifying available resources based on the operational characteristics of each specific service identified in the previous step;

- *match services to resources*; then

- *promulgate the information* to the numbered fleet commanders. [Ref. 7:p. 20]

Each of these steps will now be discussed in more detail.

1. Setting Up Services

CSS services will be defined according to the service type. The type for a specific service will consist of its particular characteristics:

- *data type*, the type of information sent over the service, may be in message, digital voice, tactical data, imagery, or file form;
- *delivery time*, the case of the information, and how quickly it must arrive at its destination(s): Case 1 (three minutes or less, Case 2 (15 minutes or less), or Case 3 (three hours or less) [Ref. 1:pp. 3-9 - 3-12];
- *delivery features*, the information may be sent via point-to-point, multicast (to two or more sites, either addressed to them individually or via a collective address), or broadcast, and may be accountable or nonaccountable [Ref. 17];
- *security requirements*, the information may be SI or GENSER, and will require a specific type of crypto equipment and keying material (keymat);
- *subscriber type*, the information may be sent or received via TDP, TTY, or FASTT subscribers [Ref. 7:p. 5];
- *service membership*, the CSS and non-CSS platforms who will be communicating within a service; and
- *theater service priority*, the recognized priority of a service within a specific COMMAREA. [Ref. 17]

Several of these characteristics require further discussion.

a. Accountable and Nonaccountable Delivery

Accountable delivery occurs when the sender is notified that the information was received. In the case of nonaccountable delivery, no notification will be received. Nonaccountable delivery might be used for reports that are

updated frequently, and consequently often superseded. [Ref. 17]

b. Service Membership

It is important that any services that consist of both CSS and non-CSS users be identified at this step in order to simplify the subsequent steps where resources will be identified and assigned to support services. This is because CSS users will need to dedicate a resource to establish and maintain communications with non-CSS users. It may even be desirable to have two similar services designated in this situation: one to support CSS communications among CSS users, and one for non-CSS communications. This configuration would be comparable to the dual UHF/EHF OTCIXS/TADIXS A operations that will exist at IOC. [Ref. 7:p. 21]

Although not required at this point, some or all desired network participants may be specified [Ref. 7:p. 21]. As previously discussed, HF or UHF LOS services such as those which support MARG or carrier operations may be added, along with specified members, to a COMMPLAN at lower command levels.

c. Theater Service Priority

Note that *theater service priority* is used on an areawide basis. Because the CSS algorithm permits each site to assign service priorities individually, a battle group's service priorities may somewhat differ from theater service priorities, and a platform's CNCTNPLAN service priorities can

differ from those of both the FLTCINC and the battle group commander. The absolute priority of a service within a specific site's CNCTNPLAN may be referred to as the *service contingency value* [Ref. 18:p. 24]. For instance, a ship receiving special support via point-to-point communications with a Naval Computer and Telecommunications Station (NCTS) would give that service a very high contingency value, where it would not even be listed in another ship's CNCTNPLAN. Thus, CSS and NECC will permit the CCC, CWC or SEWC, and TCCs to designate theater, battle group and ship service priorities respectively. In this chapter, the term *service priority* will be used to mean service contingency value unless otherwise specified.

It is recommended that the CSS COMMPLAN contain the theater service priority, but that the CWC, SEWC and TCCs assign to CSS services priorities appropriate for their missions and special requirements. Service priorities within a battle group or for particular CSS platforms could be assigned and controlled by the SEWC or the SEW Center personnel. For example, if a TCC had to change service priorities significantly due to a change in mission or in order to improve its flow of outgoing traffic, it could report the change to the SEWC or SEW Center personnel (either via voice or data), and report once again when the services reverted to the original assignment.

Should guidance be required to prioritize services within theater, the latest UHF SATCOM Prioritization Plan, developed by the FLTCINCs and promulgated by CNO, might be of some assistance. The plan lists types of UHF SATCOM networks in order of precedence and serves as guidance for communications planners when emergency preemption of a network is required. Its priorities range from 1 (highest) through 5 (lowest). Increments within each priority provide further definition of precedence. A UHF network classification related to the CSS service in question could be identified in the plan, and its priority used as a basis for discussion among planners for prioritizing CSS services.

2. Setting Up Services at IOC

The CSS COMMPLAN being generated here is in support of special operations where an EHF HICOM ANDVT service is required in addition to the exchange of EHF OTH-T information. At NECC IOC, EHF OTCIXS and TADIXS A networks will be available. In order to differentiate these networks from their UHF counterparts, EHF OTCIXS will now be referred to in this chapter as OTH-T COMMS; EHF TADIXS A will now be referred to as OTH-T BCST. Non-NECC EHF services supporting ANDVT voice and TTY communications will also be available [Ref. 17].

At IOC, *NECC* service characteristics may be defined in the following manner:

- *data types* will consist of operator-to-operator (OTO) messages and tactical data (in the form of OTCIXS message format);

- *delivery times* over OTH-T services may still be designated by the precedences Flash (Z), Immediate (O), Priority (P) and Routine (R), since message traffic may continue to be sent out over UHF SATCOM;

- *delivery features* offered will be single- or multi-destination (including broadcast), and accountable or nonaccountable [Ref. 17];

- *security requirements* supported by NECC will be GENSER, encrypted by KG-84A crypto with the appropriate keymat;

- *subscriber type* available will be the TDP Subscriber;

- *service membership* will be include NECC and non-NECC platforms at IOC; and

- *theater service priorities* may range from 1 through 5 (if the UHF SATCOM Prioritization plan is used), or a larger range of priorities may be used.

These characteristics will become more important as services start to shift toward Copernican TADIXS virtual networks and as CSS and NECC expand. In this example, several service characteristics will be used in the sample COMMPLAN and CNCTNPLAN at the end of the chapter.

The CSS service list might be considered a worksheet that planners can use to develop communications requirements, or that an individual site can use in developing its CNCTNPLAN. TABLE 1 is an example of how a CSS COMMPLAN service list might look at IOC. All six units planned to have NECC (ships A through F) are designated as service subscribers. The CCC and a NCTS have been added as shore subscribers. Note that HICOM ANDVT consists of both NECC and

non-NECC users. Ships X, Y and Z have NESP terminals, but do not have NECC.

Service numbers have been added so that they may be recognized by CSS and NECC. It is recommended that these numbers be standardized to avoid any confusion among CSS sites. It is also recommended that this standardization take place during the development of the Copernican NWP.

Upon fuller implementation of CSS, the service list and COMMPLANs could become quite large. As COMMPLANs are developed, the corresponding CNCTNPLANs will be entered into each site's data base and updated regularly, perhaps via Communications Information Bulletins (CIBs) issued by the NCTAMS. Regular updating should facilitate working with both COMMPLANs and CNCTNPLANs as they expand.

TABLE 1. SERVICE LIST

SERVICE	**SERVICE NR**	**SUBSCRIBERS**
OTH-T COMMS	OC1000	A, B, C, D, E, F, NCTS, CCC
OTH-T BCST	OB1000	A, B, C, D, E, F, NCTS, CCC
HICOM ANDVT	HI1000	A, B, C, D, E, F, X, Y, Z, CCC

3. Setting Up Resources

At this step, available resources will be identified. Available resources are resources, or percentages of

resources, not previously assigned to support services. Actual definitions of the characteristics (e.g., frequencies) of the resources will be provided by CSS and stored in its data base, so only identification of the resources themselves will be needed. Resource frequencies will be expressed in terms of frequency band, not in terms of any specific frequencies. For instance, the frequency band for OTH-T BCST will be expressed simply as EHF. [Ref. 7:p. 21]

It is well noted that until the SEWC is established and SEW Center personnel duties become clearly defined, the FLTCINC will continue to be actively involved in all use of SATCOM for accountability purposes. Since this will probably be the case at IOC, an additional column should be added to the resource list specifying which SATCOM frequencies are to be used. Once Copernican TADIXS and doctrine become firmly established, however, this responsibility could be delegated to SEW Center personnel.

CSS coordination and planning will continue to be as important as they are now. Planning requirements that cannot be met may be identified, reported and corrected at lower command levels, but it is essential that the CSS shore planning process be as comprehensive and accurate as possible. CSS planning tools should be designed to include mechanisms that will allow early identification of any deficiencies. In this manner, most problems can be resolved at the higher

command levels before promulgation to the fleet, precluding the need for emergency workarounds.

4. Setting Up Resources at IOC

NECC resources may be viewed at three distinct levels: EHF satellite capacity allocation to the FLTCINC (which may vary according to EHF satellite used, Milstar, FLTSATCOM, or UFO); the percentage of that capacity allotted to the battle group commander by the FLTCINC; and an individual platform's resources, dependent on the available satellite capacity [Ref. 10]. For this reason, and because platforms will use their resources differently, coordination with the NCTAMS is once again stressed.

Available NECC EHF resources at IOC will be restricted to those platforms that have both NESP terminals and NECC (one ashore, approximately six afloat). NESP ship/shore terminals will contain twelve resources, or ports:

- four primary transmit/receive (75-2400 bps);
- four secondary transmit/receive (75-300 bps); and
- four receive only (75-300 bps) [Ref. 10].

The receive-only LDR ports might be used for receipt of broadcasts. Four of these ports will be designated for NECC use (which four ports is not known at this time) [Ref. 17]. For discussion purposes, it will be assumed that each NECC

platform will possess two primary transmit/receive and two receive-only NECC resources.

A CSS resource list may also be considered a worksheet used by planners and TCCs in conjunction with the CSS service list when matching services to resources. TABLE 2 illustrates a sample COMMPLAN resource list at IOC. Identification numbers have been assigned to each resource so that CSS and NECC may differentiate among them. These numbers will also require standardization to avoid confusion at the next step when services are matched to resources. One suggestion would be to refer to a site's primary transmit/receive EHF resource as Resource EHF0001; the second primary transmit/receive EHF resource as Resource EHF0002, etc. In this manner, they can be differentiated from other resources (VHF, UHF SATCOM) added to CSS.

TABLE 2. RESOURCE LIST

RESOURCE NUMBER	**EHF RESOURCE**
0001	TRANSMIT/RECEIVE
0002	TRANSMIT/RECEIVE
0003	RECEIVE
0004	RECEIVE

5. Matching Services to Resources

a. Assigning Service Priorities

CSS service contingency value will depend on the site, or platform (CCC, TCC), and its mission: networks which directly support mission operations will have a higher priority [Ref. 7:p. 23]. Since HICOM ANDVT is a voice service supporting the special operations, it should be given a high priority.

Recall that service contingency values can vary from one platform to another. In this example, if a ship were not participating in the special operations, it would not be required to activate HICOM ANDVT, and HICOM ANDVT would not be in its CNCTNPLAN.

b. Matching Services to Resources

As discussed in Chapter III, multimedia access and resource sharing will provide CSS/NECC users four options:

- one resource supporting one service
- one resource supporting multiple services
- multiple resources supporting one service
- multiple resources supporting multiple services

CSS should be of some assistance to both planners and individual platforms by providing an acceptable configuration that will satisfy requirements. The OIC is planned to provide tools and templates to help determine

reasonable service-to-resource matching [Ref. 7:p. 23]. The NECC CPG/SM will automatically track service and resource memberships, providing the operator this information in display or report form [Ref. 18:p. 32].

Communications with non-CSS ships will be identified first in order to designate dedicated resources [Ref. 7:p. 22]. After this has been accomplished, remaining resources may be assigned to the other services in order of descending priority. This will ensure that the highest priority service requirements will be satisfied first.

c. Percentage Allocation of Resource (PAR) and Data Precedence Processing

After services have been matched to resources, PAR will be assigned to each service to specify allocation of resources among services. Data precedence processing (where delivery times are specified according to case) may be enabled at this point to further define resource sharing.

6. Matching Services to Resources at IOC

Matching services to resources at IOC should be a fairly straightforward procedure since the NESP terminal will provide all users in the theater four NECC resources. EHF will be the only CSS frequency band, and NECC EHF services alone may be matched to NECC resources.

At IOC, EHF communications will consist of two types of subscriber configurations:

- services among NECC users employing NESP terminal ports designated as NECC resources; or
- networks among NECC user(s) and non-NECC NESP terminal user(s) employing a NESP terminal port [Ref. 17].

The second configuration will be necessary because, as mentioned earlier, NECC platforms will be unable to use NECC to communicate via EHF with non-NECC platforms. (NECC users will still, however, maintain UHF OTCIXS and TADIXS A communications with both non-NESP and non-NECC users.) Communications among NECC and non-NECC subscribers, such as HICOM ANDVT, will require a dedicated NESP terminal port.

a. Assigning Service Priorities

When assigning service contingency values, the highest service priority should be designated first, with the lower priority services specified accordingly. These will be based on theater service priorities, but may not exactly match them. For demonstration purposes, both OTH-T COMMS (EHF OTCIXS) and OTH-T BCST (EHF TADIXS A) will be assigned a service priority of 1, although they could have been given any priority deemed appropriate for the operation being conducted (or for a particular platform's needs), and do not need to have the same priority. In case emergency restoral of CSS services should be required, HICOM ANDVT is also given a priority. Since it directly supports voice communications among the FLTCINC, numbered fleet commander and BG commander, HICOM ANDVT is also given a priority of 1.

b. Matching Services to Resources

Recall from Chapter III that *for outgoing information*, when data precedence processing is enabled and several queues have equal priority, the Subscriber Data Unit (SDU) with the highest precedence will be selected for transmission. If several queues have the same precedence, the highest priority/highest precedence SDU from the service which has not yet exceeded PAR will be selected. If neither queue has exceeded PAR, the oldest SDU with highest priority and precedence will be selected.

Only Resources 0001 and 0002 have transmit capability, so only the services assigned to these resources will require data precedence processing and PAR values. Platforms that receive the OTH-T BCST will not need to designate these parameters. However, the CSS COMMPLAN should reflect as much information regarding receive-only services as possible in case emergency preemption of services were necessary. OTH-T BCST's service priority is included.

Looking at the CSS resource list, OTH-T COMMS could be assigned to Resource 0001, a primary transmit/receive resource. Although OTH-T BCST requires only a receive-only resource, it must be assigned to a primary transmit/receive resource because its data rate is 2400 bps. A platform *receiving* OTH-T BCST could assign it to Resource 0002, using only the *receive* portion of that resource. (Note, however, that the shore station that *uplinks* OTH-T BCST would have to

designate a transmit/receive resource, using only the *transmit* portion of the resource.)

The service-resource matrix in TABLE 3 reflects a configuration temporarily dedicating Resource 0001 to OTH-T COMMS and Resource 0002 to OTH-T BCST. (Other services could be assigned to either resource at a later time.) Resource 0002 is assigned to OTH-T BCST, but is not dedicated because none of its transmission capability will be used to support OTH-T BCST.

c. PAR and Data Precedence Processing

It is important when assigning PAR to a service to remember that the number of resources available will depend on *how* the resources will be used. For instance, in TABLE 3, OTH-T COMMS is supported by Resource 0001. This resource supports no other services. Therefore, the PAR assigned to OTH-T COMMS may be 100, meaning that 100 percent of Resource 0001's transmission capability supports OTH-T COMMS. If, however, Resource 0001 were already assigned to a service or several services, a decision would have to be made on how that resource would be shared between/among the services. This decision could be made at a platform level (if an individual TCC's service were affected) or at the SEWC level (if a service with many TCC subscribers were affected), and would depend on the service priorities involved.

TABLE 3. SERVICE-RESOURCE MATRIX: DEDICATED RESOURCES

SERVICE	**SVC NR**	**EHF RESOURCES**			
		NUMBER	PRIORITY	PRECEDENCE	PAR
OTH-T COMMS	OC1000	0001	1	YES	100
OTH-T BCST	OB1000	0002	1	---	0

TABLE 3 also reflects that, since OTH-T BCST subscribers only receive information, precedence and PAR do not apply. The Precedence column is left blank. The PAR column contains a zero (0). Theater service priority is retained for information purposes in case an emergency such as resource failure were to occur.

PAR assignment will also depend on how much traffic travels over each circuit. Remember that PAR will only be used when SDUs awaiting transmission by the same resource have the same precedence (if enabled) and the same priority: when they are in contention for transmission. In these instances, the SDU from the service which *has not yet exceeded PAR* will be transmitted first.

If a service has equal priority with another sharing the same resource, but has a higher volume of outgoing traffic, it should be assigned a higher PAR. In this manner, its SDUs can experience a higher percentage of resource usage before PAR is exceeded and they come into contention with

those of the other service. If the high volume service exceeds PAR, and the low volume service has not, its SDUs will start to get "bumped" by the other service's. Only until the low volume service exceeds PAR will the oldest SDU (presumably from the high volume service) be selected for transmission.

Keeping this in mind, two transmitting services of equal priority sharing a resource *may* be assigned PAR combinations such as 45/55, 10/90, or 70/30 percent, indicating that they share 100 percent of that resource's transmission capability. They may also be assigned combinations such as 25/25, 60/20, or 40/10, indicating that 50, 20, or 50 percent (respectively) of that resource's transmission capability is still available to support another service, or other services). They will even be able to use that resource's available capacity when no other service is using it [Ref. 17].

In TABLE 4, OTH-T BCST and OTH-T COMMS share Resource 0001. Resource 0001 supports no other services. Since PAR applies to outgoing traffic only, OTH-T COMMS can still be assigned all (100 percent) of Resource 0001's transmission capability. If required, additional services could share Resource 0001. Once again, OTH-T BCST's precedence column is left blank, and its PAR remains at zero (0).

In TABLE 5, multimedia access is indicated: two resources have been assigned to OTH-T COMMS. In this case,

Resource 0001 does not support any other services and Resource 0002 supports OTH-T BCST, so each resource's PAR of 100 percent may be assigned to OTH-T COMMS. This method of resource allocation should ensure faster transmission of OTH-T COMMS information because its high precedence SDUs will have two resources over which they can be transmitted. Once again, OTH-T BCST's precedence column is left blank, and its PAR remains at zero (0).

TABLE 4. SERVICE-RESOURCE MATRIX: RESOURCE SHARING

SERVICE	**SVC NR**	**EHF RESOURCES**			
		NUMBER	PRIORITY	PRECEDENCE	PAR
OTH-T COMMS	OC1000	0001	1	YES	100
OTH-T BCST	OB1000	0001	1	---	0

Data precedence processing has been enabled in all cases. It is assumed that this practice will be preferred in most instances. Recall that in cases where data precedence is not enabled and SDUs of equal priority are in contention, PAR will be used to determine which SDU will be transmitted first.

7. Promulgating the Information

TABLE 6 is an example of how a COMMPLAN *might* look after the initial planning stage. The actual plan will be classified so that keying material (keymat) and any other classified information can be specified in the plan.

(Planners may find it valuable to include other information, such as frequencies, at the initial planning step.) The priority used here is the theater service priority, or simply the COMMPLAN priority. Resource 0002 indicates usage by the NCTS for uplinking OTH-T BCST (OB2000), and by the other NECC platforms for receiving OTH-T BCST (OB1000). Note that the CSS values (1, Y, 100) for NCTS's use of Resource 0002 are included. The NCTS might use an available resource for off-the-air monitoring of OTH-T BCST (OB1000), as Resource 0001 illustrates.

TABLE 5. SERVICE-RESOURCE MATRIX: MULTIMEDIA ACCESS

SERVICE	**SVC NR**	**EHF RESOURCES**			
		NUMBER	PRIORITY	PRECEDENCE	PAR
OTH-T COMMS	OC1000	0001	1	YES	100
	OC1000	0002	1	YES	100
OTH-T BCST	OB1000	0002	1	---	0

In order to be complete, the COMMPLAN promulgated by the CCC should contain *all* networks. Here, HICOM ANDVT is included. Its entry denotes that it will use EHF SATCOM and requires a non-NECC NESP terminal port. HICOM ANDVT also specifies such important information as theater service priority, network members and required keymat.

As discussed previously, CSS COMMPLANs will be promulgated down to lower command levels for review and further development. Modifications to theater service priority, precedence and PAR values may be made at all levels, depending on the platform's outgoing traffic requirements. Numbered fleet commanders may add other networks, parameters, and frequencies where required, including alternate frequencies and the times they are to be used. Battle group commanders may add other networks required and match platforms to services, assigning additional subscribers to services as appropriate. [Ref. 7:p. 23]

TABLE 6. A SAMPLE CSS COMMPLAN

SVC NR	**SUBSCRIBERS**	**KEYMAT**	**EHF RESOURCES**			
			NR	PRI	PREC	PAR
OC1000	A,B,C,D,E,F,NCTS, CCC	XXXXXX	0001	1	Y	100
OB1000	A,B,C,D,E,F,CCC, (NCTS)	XXXXXX	0002	1	--	0
OB2000	NCTS	XXXXXX	0002	1	Y	100
HI1000	A,B,C,D,E,F,X,Y,Z CCC	XXXXXX	--	1	--	--

Once he has received the COMMPLAN, the numbered fleet commander will review it and make any additions (smaller services), specifying frequencies and times they will be used. If there are any problems, he will advise the FLTCINC. The numbered fleet commander will also activate an individual CNCTNPLAN at his TCC.

Upon receipt of the COMMPLAN, the battle group commander will review it, delete the use of Resource 0002 by NCTS, and promulgate the information regarding OTH-T COMMS, OTH-T BCST and HICOM ANDVT to the TCCs participating in those networks. If the battle group commander identifies any problems, he will notify the numbered fleet commander. The BG commander will also activate an individual CNCTNPLAN at his TCC.

As discussed previously, resources used from ship to ship may differ, and service priority, precedence, and PAR values may vary as well. In order to arrive at the ideal configuration at his/her own site, each command will follow the first three steps of the planning approach: setting up services, setting up resources, and matching services to resources.

Upon receiving the COMMPLAN, operators will enter into the NECC all pertinent information, based on further parameters offered by the EHF Manager within the NECC. (These parameters will be based on NESP terminal operations and EHF/Milstar satellite and circuit operations [Ref. 16:p. 38].)

Once all information is entered, the operator will check the site configuration to ensure it complies with the CNCTNPLAN. If there are no problems, the CNCTNPLAN will be entered into the site's CSS data base, where it will be available for call-up, modification if required, and activation at a later time. If any problems exist with the site configuration, the operator will notify his/her superior for resolution.

TABLE 7 denotes the CNCTNPLAN of TCC A that has been entered into the CSS data base and is ready for activation. In this instance, TCC A has assigned service priorities in accordance with the CSS COMMPLAN. Should TCC A wish to transmit a message to another service member, the CSS would provide the status of that member (reachable, unreachable). Note that EHF resources used may differ from site to site.

TABLE 7. A SAMPLE CNCTNPLAN: TCC A

SVC NR	**SERVICE**	**KEYMAT**	**EHF RESOURCES**			
			NR	PRI	PREC	PAR
OC1000	OTH-T COMMS	XXXXXX	0002	1	Y	100
OB1000	OTH-T BCST	XXXXXX	0002	1	--	0
HI1000	HICOM ANDVT	XXXXXX	--	1	--	--

SEW Center personnel should have available the CNCTNPLANs of the TCCs within a FLTCINC's AOR in order to effectively manage fleet communications. Until the SEW Center

comes into being, however, the FLTCINC will remain in control of the CNCTNPLANs. He may wish to delegate their management to the numbered fleet commander who will, in turn, be supported and assisted by the NCTAMS.

C. CONCLUSION

Having just taken a closer look at the development of a CSS COMMPLAN and CNCTNPLAN, it is now easier to see how a CNCTNPLAN could become tailored to the desires and requirements of the CWC. Communications will be enhanced by CSS multimedia access and resource sharing, making better use of resources. The use of service priority, precedence and PAR values will further refine use of the resources, allowing the CWC, SEWC or shipboard communications officer (COMMO) to control the outgoing traffic of a group of TCCs or a single TCC.

TCCs that have a specific mission and transmit large volumes of information to support that mission can adjust their CSS values accordingly. Services supporting force operations or targeting may be assigned higher precedence, service priority and PAR values than other services with which they share resources. If a platform sends out equal amounts of high priority operational and administrative traffic, it can modify values to arrive at an optimum mix. These practices will ensure that other platforms will receive those high precedence, high service priority messages first.

Because there are many ways in which to formulate a CSS CNCTNPLAN, it is strongly recommended that soon after the installation of NECC, ample time be provided for individual platforms and groups of platforms to sample and test various CNCTNPLAN configurations in order to determine the advantages and disadvantages of each one. Testing will enable service members to ascertain which configuration(s) provide them the most effective and efficient performance to meet their needs.

As CSS and NECC grow, early development and updating of both CSS COMMPLANs and CNCTNPLANs will become necessary. Planning and coordination among staffs at different command levels are once again stressed. These procedures should expedite formulation of the plans. The more CNCTNPLANs that exist in a CSS data base, the easier it will be for operators to call them up for review, modification (if required) and activation. This approach should prevent the need to develop any plans from scratch on short notice.

D. SUMMARY

A CSS connection plan (CNCTNPLAN) may be considered a set of particular services, resources, and values of service priority, data precedence and PAR entered into an individual CSS site's data base to support an operation. Many types of a CNCTNPLAN may exist to support various operations: parameters such as service priorities and PARs may vary from

theater to theater, from operation to operation, from one platform to another, or even from one time period to another.

CNCTNPLANs will be based on matrices of a future NWP, and those matrices will be derived from existing Joint Doctrine, theater OPLANs, and COMMPLANs within a FLTCINC's Area of Responsibility (AOR). A CSS COMMPLAN was developed based on a proposed planning approach consisting of four steps: setting up services, setting up resources, matching services to resources, and promulgating the information.

The first three steps will also be used by each CSS site when entering its own CNCTNPLAN into CSS. An example of a TCC's CNCTNPLAN was shown based on the COMMPLAN developed and promulgated.

VI. RECOMMENDATIONS AND CONCLUSION

A. RECOMMENDATIONS

1. Planning and Management at CSS/NECC IOC

Because there are many ways in which to formulate a CSS CNCTNPLAN, it is strongly recommended that soon after the installation of NECC, ample time be provided for individual platforms and groups of platforms to sample and test various CNCTNPLAN configurations in order to determine the advantages and disadvantages of each one. Testing will enable service members to ascertain which configuration(s) provide them the most effective and efficient performance to meet their needs.

As CSS and NECC grow through the incorporation of additional communications systems, contributing to C^4I more proficiently, their planning process will become more complex. Although CSS is planned to provide assistance in matching services to resources, it is imperative that theater planners at all levels become well acquainted with these systems and their capabilities. Both operations and communications personnel must understand the alternatives that CSS and NECC can provide in order to derive the most beneficial use from them. It is also necessary that CSS sytem designers must provide adequate planning tools to CSS managers in order to facilitate their jobs at IOC.

This knowledge will also facilitate the development of the communications matrices that are to be included in the Copernican Naval Warfare Publication (NWP). It is recommended that standardization of CSS service numbers and resource numbers occurs during this process.

2. NECC

In Chapter IV, it was suggested that EHF MDR design and development continue to completion and that that capability be incorporated into the NESP terminal. A recent document reflects that the NESP terminal will be modified to accommodate EHF MDR on designated ships [Ref. 19:p. 8-7].

3. CSS

In order for the full benefits of CSS to be realized, systems interfacing with CSS should include the full range of communications possible for the transmission media being used: data, voice, imagery, and/or video-teleconferencing. Only in this manner can CSS provide a truly survivable and flexible architecture, offering each type of transmission various media, or bearer services, by which it can reach its destination.

4. COPERNICUS and CSS

Finally, the Navy must remain **committed** to the CSS architecture, seeing that it continues to incorporate new communications systems as they are developed, regardless of any problems that might occur. The worst thing that could

happen would be to suspend or cancel incorporation of additional communications systems into CSS once it has been introduced into the fleet. Termination or delay in expanding CSS due to lack of follow-through or lack of funds would render it a fragmentary system, having integrated some, but not all, communications systems to interface with it. CSS must be as comprehensive as possible in order for Copernican TADIXS and the COPERNICUS architecture itself to be effective C^2 force multipliers.

B. CONCLUSION

This thesis has attempted to incorporate all available documentation on COPERNICUS, the CSS and the NECC into a single text and common language so that it might be used as a quick reference by the managers of these systems. By so doing, it seeks to familiarize the reader with the functions and capabilities of CSS and the NECC, and their relationship to the third pillar of the COPERNICUS architecture, TADIXS, to which they belong. This thesis has also attempted to provide useful recommendations for planning and management of the CSS and NECC at IOC.

It is hoped that the reader has gained a better understanding of how CSS and NECC will interact within the Copernican architecture to enhance fleet communications and, in turn, strengthen and improve C^2 for the CWC, FLTCINC, and eventually the USCINC. It is also hoped that operations

personnel and communications managers now have a foundation on which to plan for CSS and NECC operations prior to IOC.

APPENDIX

NECC Capabilities Summary

Requirement Description	Build 1 (note 2)	Build 2 (note 3)	Build 3+
Hardware Self Test	X (note 1)	X	
Auto Startup	X	X	
X-Windows Interface	X	X	
Connection Plan Generator	X	X	
EHF Management Tools	X	X	
Trusted Operator Access Control		X	
On-line Help	X	X	
On-Line Training And Documentation	X	X	
Off-line Diagnostics		X	
ECA (Embedded COMSEC Adaptor)	X		
MSD (Modular Security Device)			X
Voice Packet Service		X	
Accountable Data Transport	X	X	
Reliable Subnet Transport Service	X	X	
Reliable End-To-End Transport Service		X	
Packet Internet		X	
Multicast Transport		X	
NSNF Protocol			X
KG-84A Link COMSEC	X	X	
TOD Link COMSEC			X
Embedded UHF SATCOM Control			X
Dual Redundant Hardware	X (note 3)	X (note 4)	
Automatic Fault Recovery		X (note 5)	
Security Manager			X (note 6)

NECC Capabilities Summary (cont'd)

Requirement Description	Build 1 (note 2)	Build 2 (note 3)	Build 2 Option
TDP Subscriber	X	X	
TTY User			X
Submarine IXS			X
Submarine Reportback			X
On-Line Alerts	X	X	
Day File Journal	X	X	
Performance Monitor	X	X	
Configuration Control	X	X	
Multimedia Selection	X (note 3)	X (note 4)	
Resource Sharing	X	X	
Single Beam EHF Subnets	X	X	
Multi-Beam EHF Subnets	X	X	
Agile Beam Controlled EHF Subnets			X
Milstar IBC Interface For Subnet Control			X
NESP Terminal Control			X
Voice Internet Service			X (note 5)
Interoperable Voice Service			X (note 6)
UHF SATCOM Interface	X	X	
ANDVT Interface	X (note 7)		
Voice Subscriber Terminal Interface		X	
STU-III Interface		X	
TADIXS Gateway Interface	X	X	
SSIXS Interface			X

Note 1: Build 1 assumes use of SCE Build 1 product
Note 2: Build 1 assumes use of SCE Build 3 product
Note 3: Includes VME processor boards only
Note 4: Includes dual redundant mass storage
Note 5: Limited to mass storage and processor components
Note 6: Requires use of SCE Build 4 product

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